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ASCENT/DESCENT ANCILLARY DATA PRODUCTION USER'S GUIDE

CR 171971

December 1986

Prepared for

CONTRACT NAS9-17554

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

LYNDON B. JOHNSON SPACE CENTER

HOUSTON, TEXAS

Prepared by

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System Development Division

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1.0 INTRODUCTION

The Ascent/Descent Ancillary Data Product, also called the A/D BET because it contains a Best Estimate of the Trajectory (BET), is a collection of trajectory, attitude, and atmospheric related parameters computed for the ascent and descent phases of each Shuttle Mission. These computations are executed shortly after the event in a post-flight environment.

A collection of several routines including some stand-alone routines constitute what is called the Ascent/Descent Ancillary Data Production Program. This document is a User's Guide for that program.

1.1 SCOPE

This document is intended to provide the reader with all the information necessary to generate an Ascent or a Descent Ancillary Data Product. It includes descriptions of the input data and output data for each routine, and contains explicit instructions on how to run each routine. A description of the final output product is given in Appendix B.

1.2 FUNCTIONAL OVERVIEW

The ascent flight phase begins at SRB ignition and terminates at orbital insertion (OMS-2). The descent flight phase, sometimes called re-entry, begins with deorbit burn ignition and terminates at rollout (i.e., when the wheels stop). By combining trajectory, attitude, and meteorological data, the Ascent/Descent Production Software provides the most comprehensive history of vehicle performance currently available.

The data production effort can be divided into the tasks:

- Data input
- Computation of the BET
- Computation of the best estimate of the attitude

- Merge the attitude estimate into the BET
- Process meteorological (MET) data
- Computation of the output products
- Creation of the output tapes

2.0 APPLICABLE DOCUMENTS

2.1 NASA/JSC DOCUMENTS

1. "OFT ASCENT/DESCENT ANCILLARY DATA REQUIREMENTS DOCUMENT," JSC-14370, A. C. Bond (JSC) and J. Knoedler (TRW), Rev. 1, February 1980.

2. "The Ascent/Entry BET Program, LRBET5," JSC-19310, December 1983.

2.2 TRW DOCUMENTS

1. "Engineering Description of the Ascent/Descent BET Product," TRW Report No. 47467-H007-UX-00, A. W. Seacord, II, August 1986.

2. "Programming Standards for FORTRAN Deliverables," TRW IOC 82:W482.1-16, D. K. Phillips, 10 February 1982.

3.0 SOFTWARE SYSTEM OPERATIONAL OVERVIEW

The Ascent/Descent Production System is a Unix based software system and, as such, utilizes Unix features. Extensive use is made of Unix shell scripts, particularly in the quality assurance software which creates plots of the various intermediate and output products. The directory structure of the Unix operating system is also utilized in order to separate the various production processes which can run simultaneously.

3.1 PRODUCTION DIRECTORY

It is assumed that a directory exists which contains the production software and files containing default values for all program inputs. This directory is under configuration control and distinct from the directory in which the Ancillary Data Product is computed. A shell script called SETUP is provided which copies all production software and default files from the configuration control directory into the production directory.

3.2 TIME CONTROL

The JSC Shuttle program generally uses time tags which measure UT ellapsed time since the start of the year in the form [day number : hr : min : sec] where 'day number' is the number of the day (i.e., UT day + 1). Some time tags, the Mission Launch Time for example, use [year : day number : seconds from midnight day of launch]. Care has been taken to prompt the user for the proper parameter.

Internally, the Ascent/Descent Production Program operates in ellapsed UT seconds from launch day. Observation data is accepted with UT time tags.

The onboard clock is generally assumed to be synchronized with ground time. However, the program has inputs for onboard time bias, onboard clock drift rate, and drift start and stop times.

4.0 OPERATIONAL PROCEDURE OVERVIEW

A functional flow of the ancillary data production process is shown in Figure 1. The operation procedure for this process can be summarized by dividing the procedure among the seven basic tasks listed in Section 1.2.

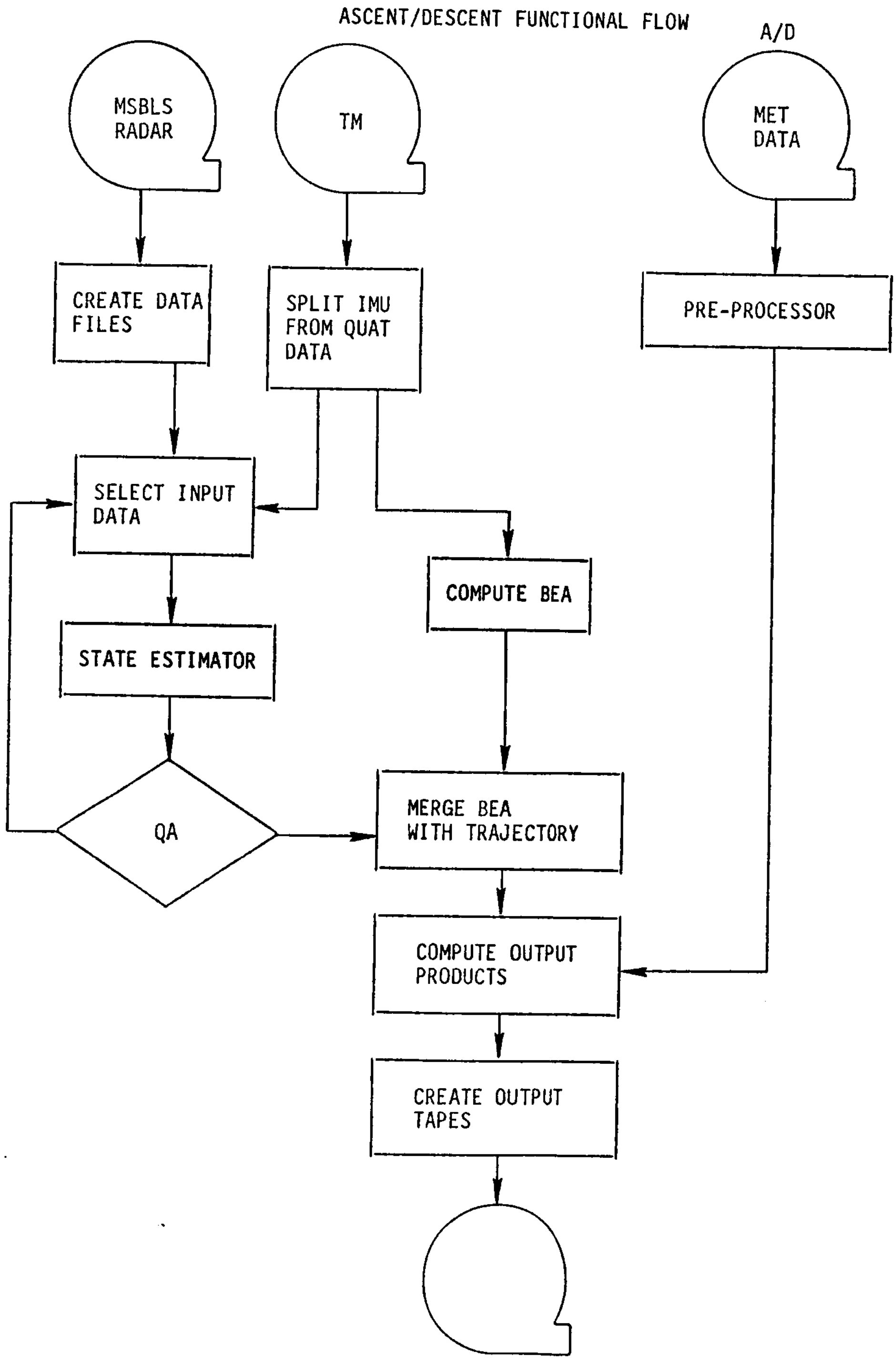

Figure 1. Ascent/Descent Functional Flow

4.1 DATA INPUT

Data are input to the production process in two ways, magnetic tape and terminal keyboard. There are four programs and one directory involved in this procedure:

ILD: This program reads the ILOAD tape and creates a file which is the input for the program INPUT.

INPUT: This program accepts the ILOAD data and the default files, and prompts the user for all keyboard entries. In enables the user to edit the input files and creates a file for each subsequent file in the production process.

UN2HP: This program reads in the MSBLS (Microwave S Band Landing System) radar data, and Space Tracking & Data Network (STDN) data, i.e., ground radar data, telemetry data, and onboard trajectory data. It reads UNIVAC magnetic tapes and outputs in HP-9000 compatible files, but it does not change the data format.

HPMET: This program reads the meteorological data tape and outputs an HP-9000 file but with no change in data format.

DEFAULT: This directory contains all default values. Mission STS-61C is the default mission - see Appendix A.

4.2 DETERMINATION OF THE BEST ESTIMATE OF THE TRAJECTORY

This task includes selection of the radar stations to be used in the Kalman filter, execution of the Kalman and smoothing filters, and quality assurance of the resulting trajectory. The principal programs used for this task are:

RDRPOS: This program converts a blended radar data stream of blocked radar data into time monotonic data sets sorted by station.

RADAR5: This program provides the radar input to the LRBET5 program.

QARESID: A program which compares radar residuals computed with the BET to the radar residuals computed with the onboard state.

TELMTR: A program which reads the telemetry data file, splits the accelerometer data from the quaternion data, and scans for gross data errors.

PLOTIMU: A Unix shell script which plots the accelerometer data output by TELMTR.

AUTOSELECT: A Unix shell script which executes the programs:

a. RDRMRG: This program splits the file containing C-band and S-band radar data into four files, three C-band files and one S-band file.

b. RADSELECT: A program which computes observation residuals based on a reference trajectory and selects the best data as a function of the smallest mean and standard deviation of the range, (C-band) azimuth, and elevation data. Since the filter will process azimuth and elevation data from only one of the three C-band files, the best data is placed in this file.

c. LRBET5: This is the Kalman Filter and the smoothing filter which produces the spacecraft position, velocity, and acceleration in the output product.

d. SPLINE: This program compares the LRBET5 trajectory output with the onboard trajectory by computing a cubic spline fit through the LRBET5 trajectory points which can then be used for interpolation to get matching time points for comparison.

Upon activating the autoselect function, RDRMRG is first executed to preprocess the radar data. Then RADSELECT is called to choose radar data based upon residuals with respect to the onboard filter trajectory. The filter is then run with this radar selection after which RADSELECT is once again called to choose radar data based this time upon the just computed LRBET5 trajectory. This newly selected radar data is then filtered and the resulting trajectory is then fitted with a cubic spline and compared to the onboard trajectory. The output from the AUTOSELECT routine is a file containing the differences between the onboard and LRBET5 position and velocity, a file from RDRMRG containing the Mean of 1950.0 position as computed directly from the radar data, and the LRBET5 output file which, upon successfully passing several quality assurance tests, is declared to be the best estimate of the trajectory. There are four quality assurance tests as follows:

QAMSLRRESID: This is a Unix shell script which executes the following two programs:

a. MSLRRESID: A program which computes the residuals of the MSBLS data with respect to the LRBET5 trajectory and outputs files containing these residuals.

b. QA: This program plots the files output by MSLRRESID.

QAMSOBRESID: A Unix shell script which executes the two programs:

a. MSOBRESID: This program computes residuals of the MSBLS data with respect to the onboard trajectory and outputs files containing these residuals.

b. QA: A program which plots the files output by MSOBRESID.

QASPLINE: This is a Unix shell script which plots the differences between the onboard and LRBET5 position and velocity from the AUTOSELECT shell script. It also calls QA for plots.

QAPLOTDIFF: A shell script which plots the difference between the LRBET5 position data converted into range, azimuth, and elevation and the equivalent actual radar terms.

LANDQA: This is a program which is executed only for a re-entry (DESCENT) BET. It computes the ground track of the spacecraft down the runway as a function of the LRBET5 trajectory and plots the result.

QAFILTER: A Unix shell script which plots selected state vector parameters from the LRBET5 filter.

When MSBLS data are used in the orbit determination process, the following programs are exercised:

MSBLS: This program separates input MSBLS data into 3 files: range, azimuth, and wedge angle.

EDITMSBLS: A program which permits manual edit of the MSBLS data.

MSLRRESID: This program computes MSBLS residuals using the LRBET trajectory.

MSOBRESID: This program computes MSBLS residuals using the onboard trajectory.

4.3 DETERMINATION OF THE BEST ESTIMATE OF THE ATTITUDE

This task consists of one main program with two quality assurance programs.

RUNBEA: This program reads the quaternion data file output by TELMTR and computes the best estimate of attitude.

EDITIMUBEA: This program allows the user to manually change either the accelerometer data or the quaternion data.

QUATQA: This is a Unix shell script which computes rotation and rotation rates from the Best Estimate of Attitude (BEA) and plots the results.

4.4 MERGING OF TRAJECTORY AND ATTITUDE ESTIMATES

This task uses only one program:

MERGE: This is a program which merges the Best Estimate of the Trajectory (BET) with the Best Estimate of the Attitude (BEA).

4.5 PROCESS METEOROLOGICAL DATA

This task incorporates meteorological (MET) data in the A/D Program and executes quality assurance on the MET data results. The programs used are:

12IIPC: This is the principal meteorological data processing program which prepares the meteorological data for inclusion in the final product.

QAMETGRAPH: A Unix shell script which plots the meteorological data.

GTRACK: This program computes the descent vehicle ground track from the onboard trajectory. The descent ground track must be sent to the National Weather Agency to obtain the necessary meteorological data.

METGRAPH: A program which plots some meteorological data and computes the geoidal height.

4.6 COMPUTATION OF THE OUTPUT PRODUCT

This task includes execution of the program which computes the final output product. The main programs are:

OPIP: This is the program which computes all parameters in the output product.

QAOPIP: This is a Unix shell script which plots selected final product parameters.

4.7 CREATION OF THE OUTPUT TAPES

This task generates all of the final output (deliverable) tapes. The following programs are used:

HP2CY: This program writes the binary output of OPIP to a Cyber compatible magnetic tape.

HP2UN: This program writes the binary output of OPIP to a Univac compatible magnetic tape.

FICHOUT: This program writes the formatted output of OPIP and I2IIPC to a Univac tape compatible for microfiche.

HPNAV2CY: This program writes the binary output of I2IIPC onto a magnetic tape in Cyber format.

HPNAV2UNV: This program writes the binary output of I2IIPC onto a magnetic tape in Univac format.

4.8 OPERATIONS FLOW

A production flow of data and computer operations is shown in Figure 2 for the usual or nominal Ascent/Descent Ancillary Data Production. In Figure 2, the relation between input data tapes, computer programs, data storage files, display plots, and output product tapes is shown. Computer programs are symbolized with rectangular blocks, and data storage files are symbolized with enlongated hexagonal boxes. The AUTOSELECT shell of Figure 2 is shown in Figure 3 where, again, the computer programs are represented with rectangular boxes and data files are represented with enlongated hexagonal boxes.

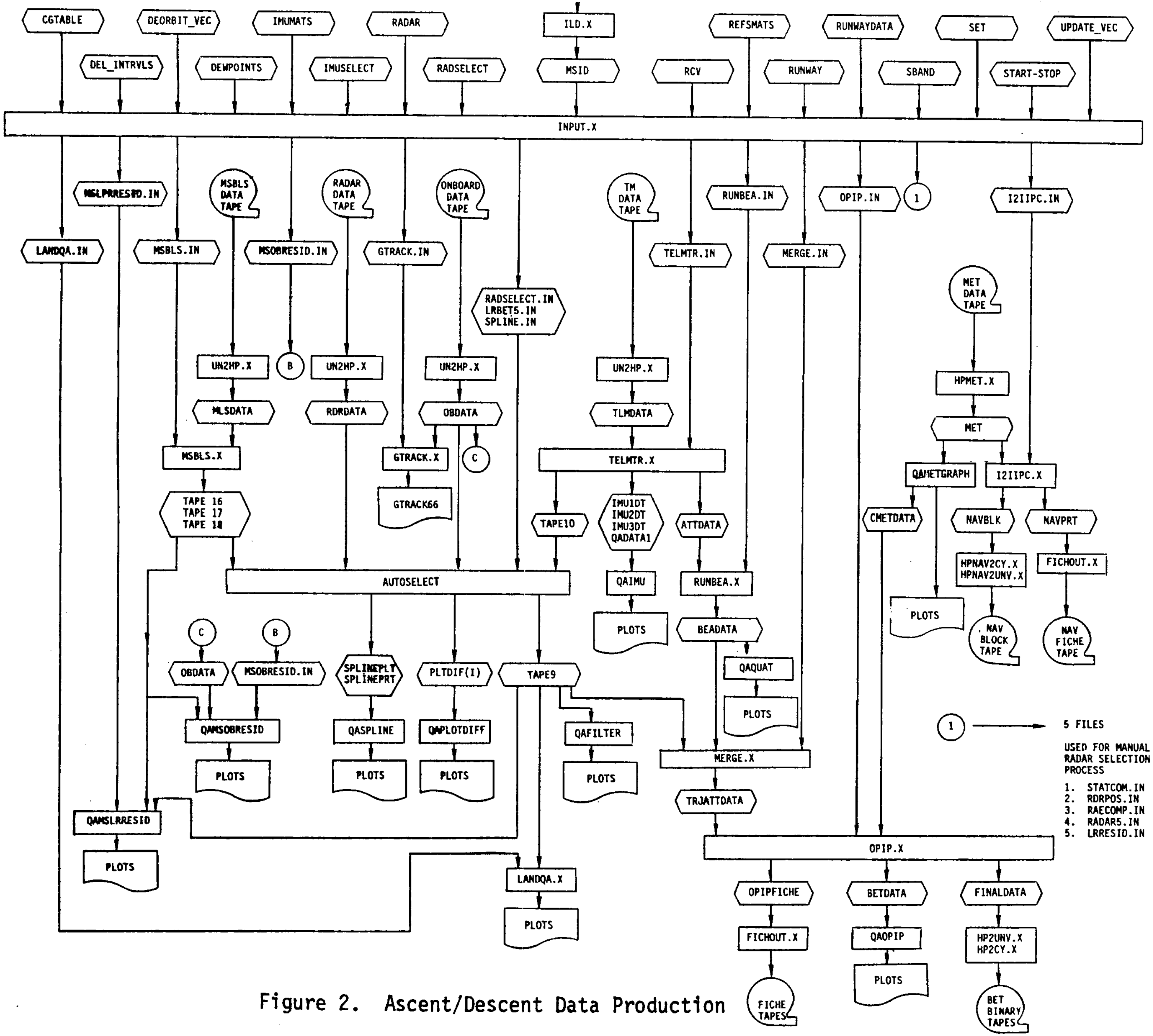

Figure 2. Ascent/Descent Data Production

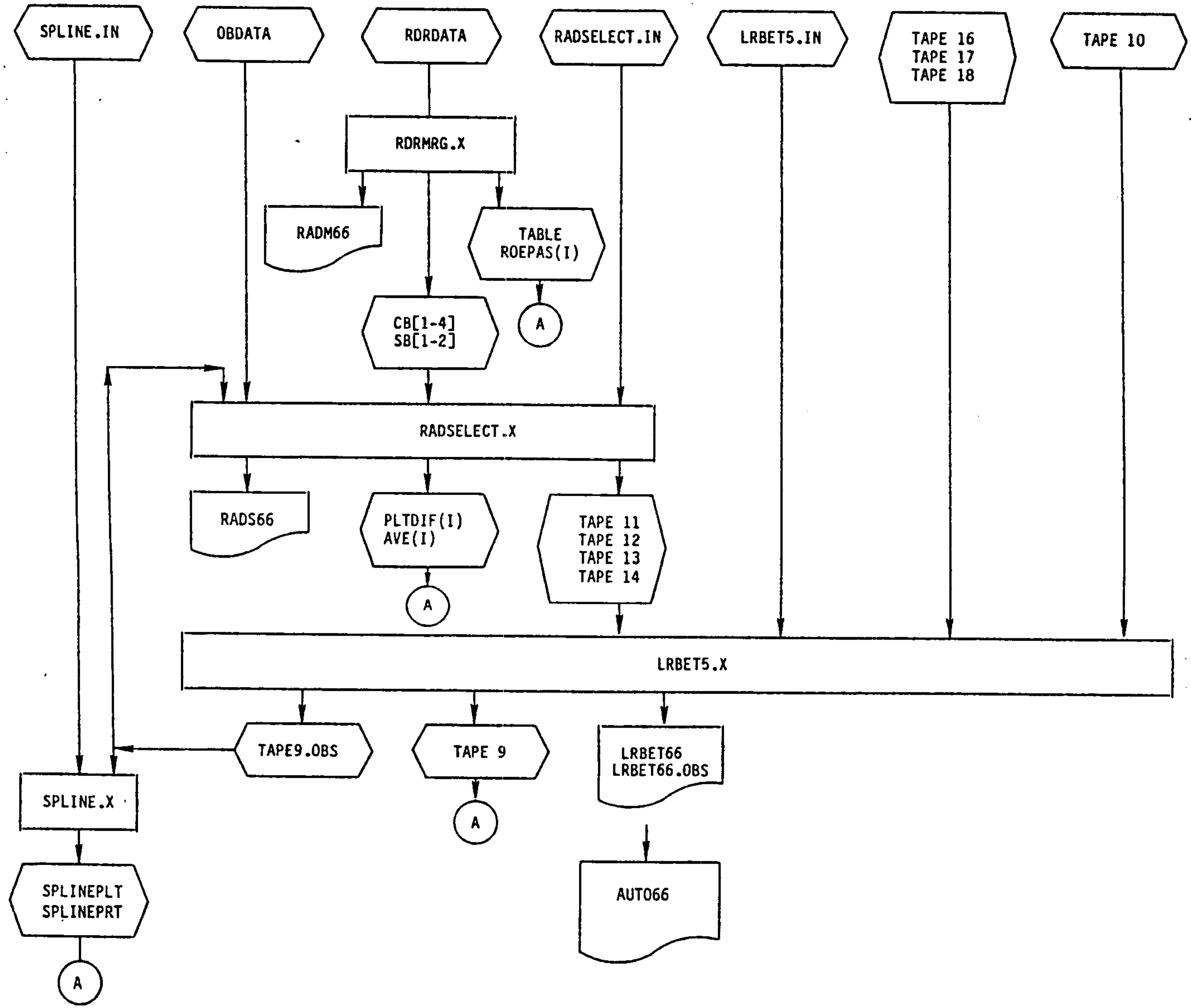

Figure 3. AUTOSELECT Process

Sometimes for investigative purposes, it is desirable to manually select radar stations. The logic flow and storage files for this procedure are shown in Figure 4, where the same symbolism is used as above.

In the process of selecting radar stations, it sometimes is necessary to directly compare the data from different stations. The radar compare procedure is shown in Figure 5.

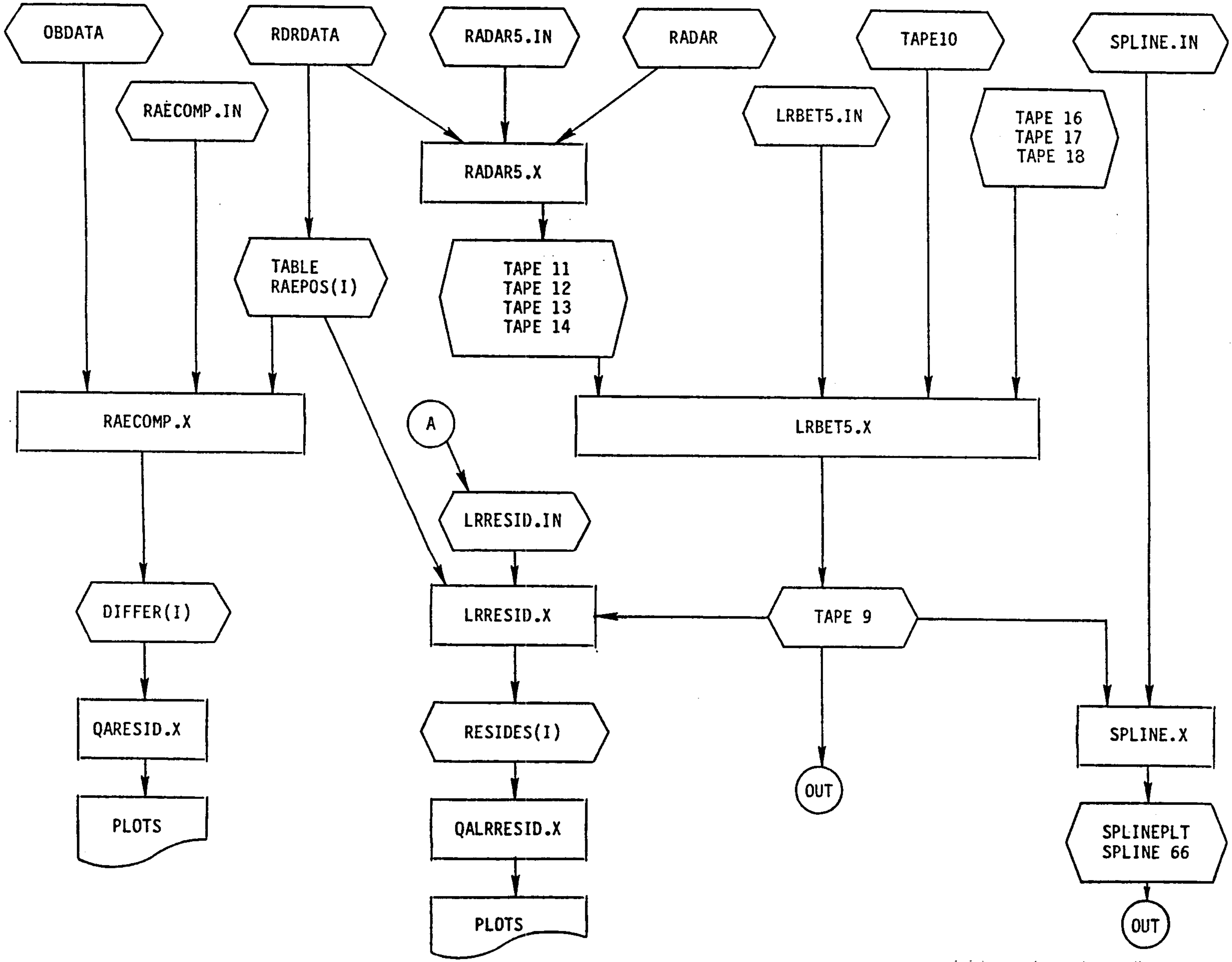

Figure 4. Manual Radar Selection

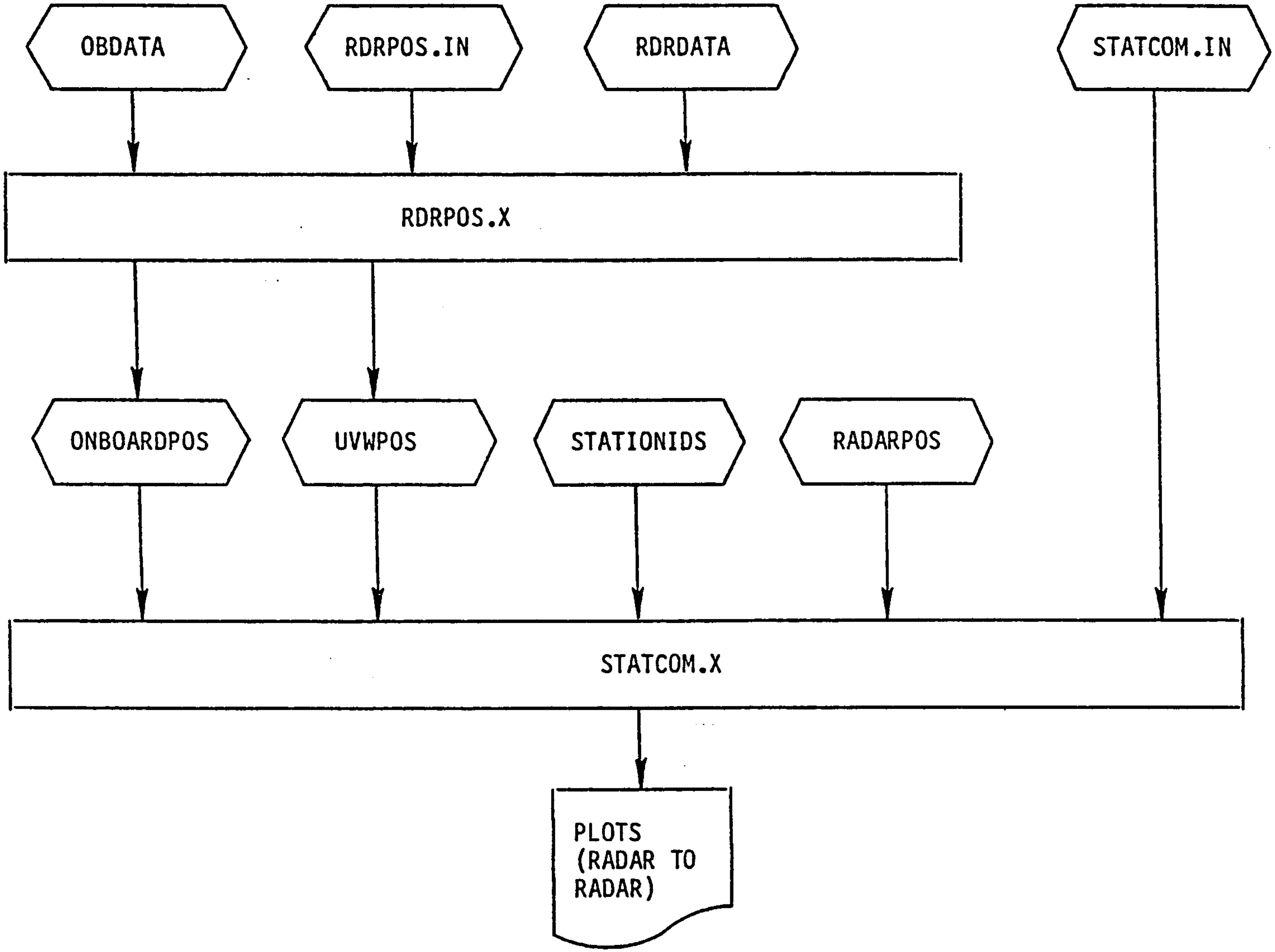

Figure 5. Radar Compare Procedure

5.0 EQUIPMENT CONFIGURATION

This program was developed for the following equipment configuration:

- HP-9040, Series 500 Computer
- HP-7971, 1600 BPI Magnetic Tape Drive
- HP-7935H, 404MB Disk Drive
- HP-2563A, 300 LPM Office Printer
- HP-45650A, PC configured as an HP-2623A Graphics Terminal

The program is not restricted to this equipment. It has been designed to be portable to any Unix based system with a graphics terminal.

6.0 INPUT MENUS

User input to the Ascent/Descent Ancillary Data Program is controlled by interactive menu selection. The various menus will both prompt and assist the user. This section instructs the user on how to interface with the various input menus. Examples of the menus used for Mission STS-61C are given in Appendix A.

6.1 MAIN MENU

Program execution is initiated by typing in and executing:

```
input.x
```

The program will respond with

```
IS THIS AN ASCENT OR A DESCENT BET? (a/d)
```

The expected response is a small "a" for an Ascent run or a small "d" for a Descent run. Either type of run begins by displaying the Main Menu for that type of run.

6.1.1 Ascent Main Menu

For ascent processing the following menu will appear:

MAIN MENU

a. START/STOP TIME	(default)
b. REFSMATS	(default)
c. CGTABLE	(default)

d. SPECIAL EVENT TIMES (default)
e. S-BAND DATA (default)
f. DEWPOINTS (default)
g. UPDATE VECTOR (default)
h. RADAR DATA DELETION INTERVALS (default)
i. SHUTTLE IMU MATRICES (default)
j. RARELY CHANGED VARIABLES (default)
k. RADAR MANUAL SELECTIONS (default)
l. IMU SELECTION FOR BEA (default)
q. QUIT

ENTER A MENU ITEM LETTER

The program will wait for the user's response. Any response except a valid one of the letters "a-l", or "q" causes the request line to be overwritten with the following comment:

xx IS AN INVALID ENTRY. TRY AGAIN.

The only escape is a valid entry. A valid entry(a-l) will replace the MAIN MENU screen with a follow-on screen. A "q" entry will quit the editing session and initiate the output processing (see output messages).

6.1.2 Descent Menu

For descent processing the following menu will appear:

MAIN MENU

a. START/STOP TIME (default)
b. REFSMATS (default)
c. CGTABLE (default)
d. SPECIAL EVENT TIMES (default)
e. S-BAND DATA (default)
f. DEWPOINTS (default)
g. DEORBIT VECTOR (default)
h. RADAR DATA DELETION INTERVALS (default)
i. SHUTTLE IMU MATRICES (default)
j. RARELY CHANGED VARIABLES (default)
k. RADAR MANUAL SELECTIONS (default)
l. IMU SELECTION FOR BEA (default)
m. RUNWAY DATA (default)
q. QUIT

ENTER A MENU ITEM LETTER

The program waits for a user response. Any response except a valid one of the letters "a-m", or "q" causes the request line to be overwritten with the following comment:

xx IS AN INVALID ENTRY. TRY AGAIN.

The only escape is a valid entry. A valid entry(a-m) will replace the MAIN MENU screen with a Sublevel Menu. A "q" entry will quit the editing session and initiate the output processing (see output messages).

6.1.3 General Sublevel Menu Presentation

There are some user actions which apply to all Sublevel Menus. These actions are displayed at the bottom of the screen on all Sublevel Menus. They appear as:

```
--------------------------------------------------------------------------

   /q = quit                  < = tab left                /i = insert line
   /a = abort                 > = tab right               /d = delete line

--------------------------------------------------------------------------
```

Upon selection of any one of the sublevel menus, the MAIN MENU is removed and the cursor will appear under the topmost field that can be updated. The common display at the bottom of each screen reminds the user as to which actions accomplish what. The up/down/left/right cursor positioning keys are operable and allow up/down/left/right movement of the cursor. Several sublevel menus are larger than one screen and paging is accomplished by movement off the bottom/top of the screen to obtain the next/previous page.

Updates are accomplished by overwriting the old numbers with the new numbers. Spaces and back-space keys do not work; use right/left cursor controls. Fields to update have been sized for nominal character length. They will not accept entries with too many characters. At the right limit of a update field, the cursor will automatically tab to the next field that can be updated. The user may thusly proceed through the menu. If no change in the value is desired, continue tabbing to the next field.

When finished with all the updates on a particular menu, the "/q" combination should be entered. When these two keys are entered, the display disappears and the following question appears:

ARE ALL THE INPUTS COMPLETE FOR THIS FILE? (y/n)

Response to this question determines the status flag on the MAIN MENU. A "y" removes the "(default)" label on the Menu Selection line. A "n" changes the "(default)" label to an "(incomplete)" label, thus flagging the need to return to this menu selection at a later editing session. After selection of either answer, the screen returns to MAIN MENU.

If the "/a" option is selected to exit the menu, then the following question appears after the menu disappears:

YOU ARE ABOUT TO END THIS EDIT SESSION
WITHOUT WRITING AN OUTPUT FILE

IS THIS WHAT YOU WANT? (y/n)

Response to this question in the negative returns the program to the previous edit session. Response to this question in the affirmative eliminates all of your edits and returns the file as it was on entry. A yes answer here returns the program to the MAIN MENU.

6.2 START/STOP MENU PRESENTATION

The START/STOP menu is generated from the START-STOP file. The following is the menu presented when an "a" is selected:

```
START TIME (seconds from midnight day of launch)..  564860.0
STOP TIME  (seconds from midnight day of launch)..  568800.0
MISSION NUMBER....................................  61C
DAY OF LAUNCH (day of the year)...................   12
LAUNCH DATE (day,month,year)......................  12 JAN 1986
TIME OF SRB IGNITION (seconds from midnight)......  42900.0
SHUTTLE MASS (kg).................................  96426.0
DRAG COEFFICIENT..................................  75.
ET-UT (ephemeris time - universal time: seconds)..  55.53
```

```
FILTER OPTIONS:
  FORWARD ONLY OR FORWARD/BACKWARD (fo/fb)........ fo
  USE UPDATE VECTOR? (y/n)........................ n
  USE C-BAND 1 DATA? (y/n)........................ y
  USE C-BAND 2 DATA? (y/n)........................ y
  USE C-BAND 3 DATA? (y/n)........................ y
  USE S-BAND DATA? (y/n).......................... y
  USE TDRS DATA? (y/n)............................ y
  USE MSBLS RANGE DATA? (y/n)..................... y
  USE MSBLS AZIMUTH DATA? (y/n)................... y
  USE MSBLS WEDGE DATA? (y/n)..................... y
```

The START/STOP menu driven input describes the inputs required and the data is straight forward. Items include parameters like start time of the mission, stop time of the mission, mission number, launch day of the year,launch year, mass, drag coefficient, and the input selection flags. This menu should be updated on a mission by mission basis and will probably be updated several times on each mission.

6.3 REFSMATS MENU PRESENTATION

The REFSMATS menu is generated from the REFSMATS input file. The following is the menu presented when a "b" is selected:

```
                          REFSMATS
   IMU1
 0.6133975386619567870d0    0.4503512978553769000d0    0.6487889885902404790d0
-0.3773152828216552730d0   -0.5545662045478820800d0    0.7416801452636718750d0
 0.6938130855560302730d0   -0.6997427940368652340d0   -0.1702450513839721680d0
```

IMU2

0.2954440712928771 97d0	-0.7317413091659600 00d0	0.6142209768295288 09d0
-0.5880846083164215 09d-1	0.6277721524240000 00d0	0.7761724591255187 99d0
-0.9535482525825500 49d0	-0.2654369473457300 00d0	0.1424389481544494 63d0

IMU3

-0.5544043183326721 19d0	0.1250686645507812 50d0	0.8227962255478000 00d0
0.7906298637390136 72d0	-0.2295741438865661 62d0	0.5676267743110656 74d0
0.2598850727081298 83d0	0.9652220010757450 00d0	0.2839386090636253 36d-1

Caution: The data received from NASA via a printout known as the General Format Printout has the REFSMATS transposed from what is needed for input. If A (i, j) denotes the received printed REFSMAT, then the order needed for input is:

```
A(1,1)  A(2,1)  A(3,1)
A(1,2)  A(2,2)  A(3,2)
A(1,3)  A(2,3)  A(3,3)
```

6.4 CGTABLE MENU PRESENTATION

The CGTABLE menu is generated from the CGTABLE input file. The following is the menu presented when a "c" is selected:

CGTABLE

For Ascent time is in seconds from SRB ignition

For Descent time is in seconds from midnight day of launch

TIME	X	Y	Z
564870.	1092.200	0.4000	375.300
565044.4	1081.700	0.4000	371.400

567067.8	1085.300	0.4000	371.400
568519.4	1083.500	0.4000	370.700
568806.8	1085.000	0.4000	368.200
568897.2	1085.000	0.4000	368.200
-9999.	-9999.	-9999.	-9999.
0.00	0.0000	0.0000	0.0000
0.00	0.0000	0.0000	0.0000
0.00	0.0000	0.0000	0.0000
0.00	0.0000	0.0000	0.0000
0.00	0.0000	0.0000	0.0000
0.00	0.0000	0.0000	0.0000

On ascent, the CG locations are entered in feet and time from SRB ignition. On descent, the CG locations are entered in inches and time is from midnight day of launch. Since the coordinate references are different, the conversion process to the nav base is different. On ascent, coordinates are entered measured from the Shuttle structure frame with its center some distance in front of the External Tank. On descent, coordinates are entered measured in another Shuttle structure frame. From time to time, the CG sources of data at NASA change their measurement systems. As a result, reconfirmation of CG data is a constant flight to flight requirement. Luckily, the CG of the Shuttle on ascent or descent doesn't change more than a couple of inches from flight to flight at the same point of the mission. Therefore, it is possible to compare mission to mission data to confirm the data entered is valid. Note that the last entry of the file is the default number(-9999.0). This default number is necessary to terminate processes in later programs.

6.5 SPECIAL EVENT TIMES MENU PRESENTATION

The SPECIAL EVENT TIMES menu is generated from the SPECIAL EVENT TIME (SET) input file. The following is the menu presented when a "d" is selected:

SPECIAL EVENT TIMES

(DAYS REFERS TO THE NUMBER OF DAYS SINCE LAUNCH)

DAYS	HOURS	MINUTES	SECONDS	SPECIAL EVENT DESCRIPTION
6	12	54	30.000d0	DEORBIT BURN IGNITION
6	12	58	22.000d0	DEORBIT BURN CUTOFF
6	13	28	3.000d0	ENTRY INTERFACE (400000 FT)
6	13	45	32.000d0	BLACKOUT END
6	13	52	46.000d0	TAEM
6	13	58	51.000d0	MLG CONTACT
6	13	59	7.000d0	NLG CONTACT
6	13	59	50.000d0	WHEEL STOP
-99	99	99	99.d0	

The last entry is a special default value: the day is a -99; with hours and minutes a 99; and seconds a 99.d0. The default value must be present as the last value although lines can be deleted or new events added to the basic events.

6.6 S-BAND DATA MENU PRESENTATION

The S-BAND DATA menu is generated from the SBAND input file.The following is the menu presented when a "e" is selected:

S-BAND FREQUENCIES

STATION ID	FREQUENCY (HZ)
BDAS	2106384288.0
GDSS	2106406288.0
GDXS	2106406288.0
GWMS	2106406288.0
HAWS	2106406288.0
MLXS	2106423296.0
MILS	2106422288.0
MADS	2106406300.0
ORRS	2106406300.0
MAXS	2106406300.0
ACNS	2106406300.0
AGOS	2106406300.0
BLXS	2106406300.0
CANS	2106406300.0
VANS	2106406300.0

TRANSPONDER DELAY = 137.0 METERS

The station ID is not an updatable field on this display since all of the s-band stations available for use are listed here. The program's reading of the frequencies is dependent on the position and order of the stations in the list. The transponder delay is updatable and varies from Shuttle to Shuttle.

6.7 DEWPOINTS MENU PRESENTATION

The DEWPOINTS menu is generated from the DEWPOINTS input file. The following is the menu presented when a "f" is selected:

DEWPOINTS

MONTH (ENTER AN INTEGER BETWEEN 1 AND 12)... 1

STATIONS WHOSE DATA IS CORRECTED FOR REFRACTION ONSITE

ANTC	CNVC	GBIC	GTKC	KPTC	MLAC	PATC	PAFC
CNMC	MLMC	CNOC	KMTC				

STATION ID	DRY BULB TEMP (DEG. F)	WET BULB TEMP (DEG. F)	PRESSURE (MB)
VDBC	60.0	56.0	1009.0
VDFC	56.0	51.0	945.0
EFFC	50.0	46.0	937.0
FRCC	47.5	43.0	934.3
SNFC	59.0	56.0	988.5
	-9999.	-9999.	-9999.

The program has a large table of mean monthly refraction values. This table contains the mean monthly refraction values for 53 stations for each month of the year. Data entered in the 'month' selects the mean monthly refraction value for all stations. The radar data is then corrected for refraction using the mean monthly refraction value for the user specified month.

Some stations, however, have already included the refraction correction in their data. These data should not be corrected for refraction. By entering the station ID in "STATIONS WHOSE DATA IS CORRECTED FOR REFRACTION ONSITE", the program will overlay the above average monthly refraction value with a zero. Up to 16 stations are allowed for this entry, but the 12 shown in the example have traditionally covered 99% of all stations who provide their own refraction correction. Occasionally, stations that claim to correct their radar data for refraction deliver uncorrected data. Such data is apparent to the experienced user and, for such cases, the station may be deleted from the list. But, be cautious. The program reads the entries from left to right, first line 1 and then line 2, and reading is terminated short of 16 entries by a blank entry. Thus, don't just blank out an entry unless it has been moved to the end of all entries.

Whether to add refraction correction or not to add refraction correction should never be taken lightly. In at least one situation, data which was specified to be non-corrected, turned out to be corrected.

For some stations, either because they are not in the original list of 53 or because their atmospheric conditions are too far removed from the monthly mean, it becomes necessary to compute the refraction correction. These station ID's are entered in the next part of this menu with their dry and wet bulb temperature in degrees Fahrenheight and their atmospheric pressure in millibars. This part of the menu will allow up to 100 different radar stations. Data entry is terminated short of 100 by a -9999 in the temperature and pressure columns.

6.8 DEORBIT VECTOR MENU PRESENTATION (DESCENT ONLY)

The DEORBIT VECTOR menu is generated from the DEORBIT_VEC input file. The following is the menu presented when a "g" is selected:

DEORBIT VECTOR

VECTOR IS TIME TAGGED AT FILTER START TIME

X = 5846678.8

Y = -697302.0

Z = -3201586.8

XDOT = 1075.8247

YDOT = 7636.811

ZDOT = 318.1832

The program assigns a time to the vector that is the same as the start time of the mission (see START/STOP Menu). Position and velocity data should be entered in Mean-of-50 meters and meters/second respectively. This data menu is not required on ascent.

6.9 UPDATE VECTOR MENU PRESENTATION (ASCENT ONLY)

The UPDATE VECTOR menu is generated from the UPDATE_VEC file. The following is the menu presented when a "g" is selected:

UPDATE VECTOR

VECTOR IS TIME TAGGED AT FILTER STOP TIME

X = 5846678.8

Y = -697302.0

Z = -3201586.8

XDOT = 1075.8247

YDOT = 7636.811

ZDOT = 318.1832

The program assigns a time to the vector that is the same as the stop time of the mission (see START/STOP Menu). Coordinates are in Mean-of-50 coordinates (meters & meters/second). This file is only used for ascent and then only rarely. Descent update vector is calculated using the roll out position defined in RUNWAY DATA menu (see Section 6.15). Data in this menu are used only if the selection flag is set in the START/STOP menu (see Section 6.2 above).

6.10 RADAR DATA DELETION INTERVALS MENU PRESENTATION

The RADAR DATA DELETION INTERVALS menu is generated from the DEL_INTRVLS input file. The following is the menu presented when a "h" is selected:

RADAR DATA DELETION INTERVALS
(units are seconds from midnight day of launch)

	START	STOP
C-BAND 1		
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0

	0.d0	0.d0
C-BAND 2	START	STOP
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
C-BAND 3	START	STOP
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
S-BAND	START	STOP
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
TDRS	START	STOP
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
MSBLS RANGE	START	STOP
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
MSBLS AZIMUTH	START	STOP
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0
MSBLS WEDGE	START	STOP

0.d0	0.d0
0.d0	0.d0
0.d0	0.d0

The data is entered in pairs with the first entry the start time of the deletion and the second entry the stop time of that interval. There are eight interval deletions possible for the primary c-band radar(cb1). There are six interval deletions possible for the secondary c-band radar(cb2). There are six interval deletions possible for the third c-band radar(cb3). There are five interval deletions possible for the s-band radar(sb). There are five interval deletions possible for the TDRSS data. There are three interval deletions possible for the MSBLS range data. There are three interval deletions possible for the MSBLS azimuth data. There are three interval deletions possible for the MSBLS wedge angle data.

This menu is used to delete radar data from the filter (LRBET5) without reprocessing the radar tapes. Generally, the intervals are small (several seconds) and a rerun can be accomplished quickly using these intervals. On most missions, a change to this menu is not necessary. This menu is one of the menus that require multiple pages for the screen.

6.11 SHUTTLE IMU MATRICES MENU PRESENTATION

The SHUTTLE IMU MATRICES menu is generated from the IMUMATS input file. The following is the menu presented when a "i" is selected:

SHUTTLE IMU MATRICES

NAV BASE TO CASE TRANSFORMATIONS

IMU-1

0.0d0	0.0d0	0.0d0
0.0d0	0.0d0	0.0d0
0.0d0	0.0d0	0.0d0

IMU-2

0.0d0	0.0d0	0.0d0
0.0d0	0.0d0	0.0d0
0.0d0	0.0d0	0.0d0

IMU-2

0.0d0	0.0d0	0.0d0
0.0d0	0.0d0	0.0d0
0.0d0	0.0d0	0.0d0

NAV BASE TO BODY TRANSFORMATION

0.0d0	0.0d0	0.0d0
0.0d0	0.0d0	0.0d0
0.0d0	0.0d0	0.0d0

ROLL GIMBAL AZIMUTH OFFSET (RADIANS):

IMU-1............................. 0.0000000000000
IMU-2............................. 0.0000000000000
IMU-3............................. 0.0000000000000

ROLL GIMBAL PITCH OFFSET (RADIANS):

IMU-1............................ 0.0000000000000

IMU-2............................ 0.0000000000000

IMU-3............................ 0.0000000000000

This menu is not necessary if a valid I-load tape is available. The data in this menu are for manual insertion of something different than the I-load tape data. If data is written in this file, it overrides the data on the I-load tape. This menu is one of the multiple page menus. Data in the menu should normally be all zeros.

6.12 RARELY CHANGED VARIABLES MENU PRESENTATION

The RARELY CHANGED VARIABLES menu is generated from the RCV file. The following is the menu presented when a "j" is selected:

RARELY CHANGED VARIABLES

AETA: CORRECTION IN SECONDS TO PRODUCE ASTRONOMIC
LONGITUDE FROM GEODETIC LONGITUDE
ASCENT - LAUNCH PAD; DESCENT - RUNWAY.................. 0.0d0

AGH/DGH: GEODETIC HEIGHT OF THE LAUNCH PAD/RUNWAY IN FEET.... -113.0d0

AXIS: CORRECTION IN SECONDS TO PRODUCE ASTRONOMIC
LATITUDE FROM GEODETIC LATITITUDE
ASCENT - LAUNCH PAD; DESCENT - RUNWAY.................. 0.0d0

CALABC: REFRACTION CONSTANTS FOR CALIFORNIA COSTAL STATIONS

CALABC(1).. 20285.d0

CALABC(2).. 40.0d0

CALABC(3).. 0.0d0

CGSIGS: STANDARD DEVIATIONS OF THE CG LOCATION (FEET)

X.. 1.0d0

Y.. 1.0d0

Z.. 1.0d0

CGTAXES: AXIS DIRECTIONS FOR CG INPUT COORDINATES

X.. -1.0d0

Y.. 1.0d0

Z.. -1.0d0

CGTCON: CONVERSION CONSTANT FOR THE CENTER OF GRAVITY TABLE

ASCENT - 1 (FEET) ; DESCENT - 12 (INCHES)............ 12.d0

CGTREF: REFERENCE POINT FOR CONVERTING THE CENTER OF GRAVITY

TABLE FROM STRUCTURAL TO BODY AXIS COORDINATES

X.. 419.187d0

Y.. 0.0d0

Z.. 422.d0

COVAR: LOGICAL FLAG

TRUE - INPUT COVARIANCE MATRIX

FALSE - INPUT STANDARD DEVIATIONS..................... FALSE

CUVW: THE COVARIANCE OF THE INITIAL POSITION AND VELOCITY

IN UVW COORDINATES:

132.00d0	0.0000d0	0.0000d0	0.0000d0	-.9400d0	0.0000d0
0.0000d0	1000.0d0	0.0000d0	-.9900d0	0.0000d0	0.0000d0
0.0000d0	0.0000d0	66.000d0	0.0000d0	0.0000d0	0.0000d0
0.0000d0	0.0000d0	0.0000d0	1.1500d0	0.0000d0	0.0000d0
0.0000d0	0.0000d0	0.0000d0	0.0000d0	0.1200d0	0.0000d0
0.0000d0	0.0000d0	0.0000d0	0.0000d0	0.0000d0	0.0800d0

DEBUG: LOGICAL PRINT FLAG.................................... FALSE

DELTTE: ERROR BETWEEN ONBOARD AND GROUND BASED CLOCKS
AT EPOCH (SECONDS).................................... 0.0d0

DRFTRT: ONBOARD CLOCK DRIFT RATE (SECONDS/SECOND)............ 0.0d0
(N.B. : DRFTRT AND REFTM ARE RELATED)

DTWRITE: NO. OF CYCLES BETWEEN PRINTOUTS IN LRBET5 (P(2)).... 10.0

EQRADM: EQUATORIAL RADIUS OF THE EARTH (METERS).............. 6378166.0d0

GEODH: HEIGHT OF MEAN SEA LEVEL WITH RESPECT TO THE
REFERENCE ELLIPSOID AT THE LAUNCH SITE (ASCENT)
OR RUNWAY (DESCENT)................................... -208.0d0

GMTCONS: GMT SECONDS FROM MIDNIGHT DAY OF LAUNCH ON THE
ONBOARD CLOCK CORRECTED WITH DELTTE................. 0.0d0

GRR: GUIDANCE REFERENCE RELEASE TIME IN SECONDS FROM
MIDNIGHT DAY OF LAUNCH. THIS IS THE TIME AT WHICH THE
IMU'S ARE RELEASED (NORMALLY AT SRB IGNITION)........... 0.0d0

J2: EARTH GRAVITATIONAL HARMONIC.............................. 0.001082627d0

MUE: EARTH GRAVITATIONAL CONSTANT (METERS**3/SEC**2)......... 398600470000000.0

NAVGEAR: POSITION OF THE NAV BASE RELATIVE TO THE MAIN
LANDING GEAR IN BODY AXIS COORDINATES (METERS)
X... 19.128d0
Y... 0.0d0
Z... -6.388d0

NAVO: REFERENCE POSITION OF THE NAV BASE IN STRUCTURE
COORDINATES (FEET)

X.. 34.93225d0
Y.. 0.0d0
Z.. 35.16670d0

OFFSET: ONBOARD CLOCK BIAS (SECONDS).......................... 0.0d0

P(133): PRINT FLAG IN LRBET5.................................. 0.0d0

OMEGAE: EARTH ROTATION RATE (RADIANS/SEC).................... 7.2921151464592d-5

REFTM: TIME AT WHICH THE ONBOARD CLOCK BEGAN TO DRIFT........ 0.0d0
(N.B. : REFTM AND DRFTRT ARE RELATED)

RELLIP: RECIPROCAL OF THE EARTH ELLIPTICITY.................. 298.3d0

RSCALE: SCALING RADIUS FOR GRAVITATION (METERS).............. 6378139.0d0

SBTAR: NUMERATOR AND DENOMINATOR OF S-BAND TURNAROUND RATIO

NUMERATOR.. 240.0d0
DENOMINATOR.. 221.0d0

SHA: 'A' COEFFICIENTS FOR SCALE HEIGHT

SHA(1)... 17590.0d0
SHA(2)... 18588.0d0
SHA(3)... 21273.0d0

SHB: 'B' COEFFICIENTS FOR SCALE HEIGHT

SHB(1)... 30.55d0
SHB(2)... 40.814d0
SHB(3)... 60.227d0

SHC: 'C' COEFFICIENTS FOR SCALE HEIGHT

SHC(1)... 0.0d0
SHC(2)... 1500.0d0
SHC(3)... 3000.0d0

SHBREAK: ALTITUDE BREAK POINTS FOR SCALE HEIGHT

SHBREAK(1).. 1000.0d0

SHBREAK(2).. 2500.0d0

Many options and constants are entered through the RCV file. A complete understanding of all the code variables is necessary to effectively use these options. Suffice to say, 99% of the processing of the ascent/descent process can be accomplished without changes in this file. Changes in these variables should be made only if the consequencies of the change is fully understood. The menu accompaning this file describes the variable adequately to identify the code effected by its modification. This menu contains multiple pages.

6.13 MANUAL RADAR SELECTIONS MENU PRESENTATION

The MANUAL RADAR SELECTION menu is generated from the RADSELECT input file. The following is the menu presented when a "k" is selected:

MANUAL RADAR SELECTION

(Set Low rate to 1 if Low rate data)

C-BAND 1	STATION ID	START TIME	STOP TIME	LOW RATE
	KPTC	567390.1d0	567475.1d0	0
	VDFC	568024.1d0	568062.1d0	0
	VDBC	568062.11d0	568294.1d0	0
	FRCC	568294.11d0	568724.1d0	0
		000000.0	000000.0	0
		000000.0	000000.0	0
		000000.0	000000.0	0
		000000.0	000000.0	0

		000000.0	000000.0	0
		000000.0	000000.0	0

-- (page 1) --

C-BAND 2	STATION ID	START TIME	STOP TIME	LOW RATE
	SNFC	568047.1d0	568099.1d0	0
	VDFC	568099.11d0	568218.1d0	0
	SNFC	568218.11d0	568315.1d0	0
	EFFC	568315.11d0	568722.1d0	0
		000000.0	000000.0	0
		000000.0	000000.0	0
		000000.0	000000.0	0
		000000.0	000000.0	0
		000000.0	000000.0	0
		000000.0	000000.0	0

-- (page 2) --

C-BAND 3	STATION ID	START TIME	STOP TIME	LOW RATE
	VDFC	568062.1d0	568070.1d0	0
	SNFC	568099.11d0	568218.1d0	0
	VDFC	568218.11d0	568294.1d0	0
	VDBC	568294.11d0	568371.1d0	0
		000000.0	000000.0	0
		000000.0	000000.0	0
		000000.0	000000.0	0
		000000.0	000000.0	0
		000000.0	000000.0	0
		000000.0	000000.0	0

-- (page 3) --

S-BAND	STATION ID	START TIME	STOP TIME	LOW RATE
	GWMS	566399.1d0	566769.1d0	1
	GDXS	568192.1d0	568707.1d0	0

000000.0	000000.0	0
000000.0	000000.0	0
000000.0	000000.0	0
000000.0	000000.0	0
000000.0	000000.0	0
000000.0	000000.0	0
000000.0	000000.0	0
000000.0	000000.0	0

-- (page 4) --

This menu is used only for manually selecting the radars. If the AUTOSELECT process is used, then disregard the update of this menu. The first entry is a four letter (upper case) ID code of the radar station. The station ID is as defined on the radar printout recieved from NASA (Ground Track Tape dump). Start time and stop times are for the period of radar usage of that station. Times should not overlap within any BAND. The fourth entry is a flag for low rate/high rate data. (High rate data is defined as one tenth second data rate; low rate data is generally 6 or 10 second data.) Each radar slot for the filter has the capability of ten intervals. There are three c-band stations and one s-band station slot capabilities. S-band radars should be assigned to the S-band slot; C-band radars assigned to a C-band slot. Slot #1 (C-band 1) uses range, azimuth, and elevation data so it should be the best c-band radar available. C-band 2 and 3 only use range data. The S-band slot uses both range and doppler measurements. A C-band radar can be switched from slot to slot so long as times do not overlap.

Note: Times should not terminate on an even second, e.g., 56681.0. An even termination time will interfere with the filter operation. This menu consists of multiple pages.

6.14 IMU SELECTION FOR BEA MENU PRESENTATION

The IMU SELECTION FOR BEA menu is generated from the IMUSELECT input file.

The following is the menu presented when a "1" is selected:

IMU SELECTION FOR BEST ESTIMATE OF ATTITUDE

TIME	OPTION	TOLERANCE
566830.0d0	7	0.0500d0
567000.0d0	7	0.0500d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0

-- (etc., as needed) --

This menu allows the selection of which quaternion data to use and for which interval. Intervals are chosen for quaternion tolerances to delete quaternion measurements greater than this criteria. These same or different time intervals may be used for IMU quaternion selection criteria (eg., imu 1 only; average imu 1 and 2 ,etc). There are 7 options available for imu quaternion selection as follows:

(1) imu 1 prime selection
(2) imu 2 prime selection
(3) imu 1 and imu 2 average
(4) imu 3 prime selection
(5) imu 1 and imu 3 average
(6) imu 2 and imu 3 average
(7) average all three or let program select

Normally, IMU quaternion selection option #7 is chosen.

It is always necessary to select at least one time interval, but there may be no change in option or tolerance. The normally selected time is some midpoint of the mission. The first time is always the start time of the mission. There is a capability in the menu to accept up to 50 time intervals if desired.

6.15 RUNWAY DATA MENU PRESENTATION (DESCENT ONLY)

The following is the menu presented when a "m" is selected:

```
                         RUNWAY DATA

           ROLLOUT VECTOR IS TIME TAGGED AT FILTER STOP TIME
        LATERAL DISPLACEMENT IS MEASURED POSITIVE TO THE RIGHT OF
                       RUNWAY CENTERLINE

RUNWAY ID........................................ edw22

TOUCHDOWN:
  DISTANCE TO RUNWAY THRESHOLD................... 572.0
  LATERAL DISPLACEMENT OF MAIN GEAR MIDPOINT..... 0.0

ROLLOUT:
  DISTANCE TO RUNWAY TRESHOLD.................... 11727.0
  LEFT MAIN LATERAL DISPLACEMENT................. -11.347
  RIGHT MAIN LATERAL DISPLACEMENT................ 11.347
```

This menu is used on descent only to document the final rollout position and the touchdown point. The runway ID is always a three letter, lower case plus the runway designation. The sample in Appendix A uses Edwards AFB runway

22. Data in the touchdown/rollout areas are in feet. Rollout distance is used to calculate the final Mean-of-50 coordinates for the update vector. Touchdown point is only used in the plotting of the LANDQA plots. The time tag of the final rollout vector is taken as the temination of the filter run as defined in mission stop time on the START/STOP Menu.

7.0 CLEAR5

7.1 CLEAR5 FUNCTIONAL DESCRIPTION

This program is interactive and included in the AUTOSELECT shell script. It has the function of resetting the file LRBET5.IN to allow the forward/backward execution of LRBET5. In particular, it is used to modify the "P" array values (121) and (167). These array values provide coding to LRBET5 to change from a forward only to a forward/backward run and vice versa. The construction is such that any other variable in LRBET5.IN may also be changed. The program is not normally used for changing the variables in LRBET5.IN since the changes are not recorded anywhere for archival purposes and non-documented runs could be left in the production directory. The specific CLEAR5 functions are:

(1) Read the file, LRBET5.IN, to get inputs.

(2) Request which variables to change.

(3) Request which elements in the array to change.

(4) Request the new value of the change element.

(5) Replace the old value with the new value and write out the changed file, LRBET5.IN.

7.2 CLEAR5 OPERATIONAL DESCRIPTION

CLEAR5 is normally only used in the shell script AUTOSELECT. The shell script generates the answers for the questions the program asks automatically. No intervention by the user is required to operate the program. Manual execution of the program is discouraged since configuration control of the final product is undetermined by use of the program outside of the shell script.

7.2.1 Equipment Configuration

The standard Ascent/Descent equipment configuration is needed.

7.2.2 Input Items

There is one binary file read by the program as input. The program requires manual response to 3 or 4 questions as defined below.

7.2.2.1 Sample Input

Upon execution of the program the following question will be presented:

"What do you wanna change huh (p,ps,cuvw,x)?"

Response should be one of the four choices presented. If something other than one of these is presented the program ends without changing anything. The program then asks the following question:

"what index huh?"

Response to this question should be a positive integer. If the initial array response was for "cuvw", the following response is given by the program:

"what is the second index?"

Response to this question should be a positive integer. The program then prompts with the following request:

"XX(YY) = ZZZ" or "XX(YY,WW) = ZZZ"

Where XX is the array choice (p,ps,cuvw,x); YY is the first index; WW is the second index; and ZZZ is the current value of that array. The program waits for the user to enter the changed value of the array. If a blank or carriage return, <CR>, is entered, the program writes a zero in the array value. Otherwise, it accepts the entered number as a change to the old value. If the displayed value is correct, it must be reentered. The program rewrites the file, LRBET5.IN, and quits.

7.2.2.2 Definition of Inputs

The input file, named LRBET5.IN, has the following format:

item	type	contents
cuvw	dp	6 x 6 array containing the a priori covariance matrix stored by rows.
p	dp	540 word array, "the p array", which contains all of the common variables needed by the LRBET5 filter (see document 2 in Section 2.1).
ps	dp	372 word array which contains all of the radar station data in groups of 6 in the sequence: latitude (rad) longitude (rad) altitude (m) refraction coefficient refraction parameter (m) s-band frequency (Hz)
x	dp	20 word array which contains the initial state vector.

7.2.2.3 Sample of CLEAR5 Input

When CLEAR5 executes, it writes its input out to a file named CLEAR66 and displays the contents of this file to the user. One peculiarity of this display: The display of the p array and the ps array contain integers which are not in the array but which specify the number of the next array element. The purpose of these integers are to help the user find, say, the 58th element without having to count.

The following is a compressed sample of the CLEAR66 file:

```
  clear5 version of 6 aug 1986

   *** lrbet5.in ***

cuvw=   132.000000       .000000       .000000       .000000       .000000       .000000
          .000000   1000.000000       .000000       .000000       .000000       .000000
          .000000       .000000     66.000000       .000000       .000000       .000000
          .000000      -.990000       .000000      1.150000       .000000       .000000
         -.940000       .000000       .000000       .000000       .120000       .000000
          .000000       .000000       .000000       .000000       .000000       .080000

 x =   5846678.800   -697302.000 -3201586.800    1075.8247     7636.8110      318.1832
              .000          .000         .000        .0000         .0000         .0000
              .000          .000         .000        .0000         .0000         .0000
              .000          .000
 the p array is

 1             57.29577      10.0000000                .000100               1.000000
 5           1800.00000      30.0000000               2.000000       299792458.000000
 9               .00007 6378139.0000000                .001082 398600470000000.000
13 4902780000000.00000 *************** 398615280000000.000             6378166.000000
17               .00335 6378000.0000000                .000320            8000.000000
21               .20000    1000.0000000               1.500000             600.000000
25              2.00000     400.0000000               5.000000               6.000000
29              6.00000       7.0000000               4.000000                .000006
33               .00000    9000.0000000           47250.000000                .000160
37               .00084        .0000002              12.000000                .000100
41               .00015      12.0000000              12.000000              28.000000
```

45	8.00000	.0003500	.000350	400.000000
49	400.00000	10.0000000	.000150	.000200
53	10.00000	10.0000000	2.000000	.008000
57	60.00000	8.0000000	.000500	.000500
61	137.00000	.0010000	.001000	.001000
65	1.08597	1000.0000000	240000000.000000	240000000.000000
69	1000.00000	.0000000	249.900000	96426.000000
73	75.00000	.0204600	.842100	.909000
77	2.16900	.0000000	.500000	.333333
81	.66666	1.0000000	.125000	.055555
85	.00000	.1111111	.000000	.111111
89	.00000	-.7272727	.818181	.409090
93	.09166	-.2666666	.450000	.225000
97	.00000	.0916666	-.533333	.675000
101	.67500	.0916666	.000000	10000.000000
105	5000000.00000	6.2831853	1.800000	140000.000000
109	4.00000	.0000000	77422.000000	871960.000000
113	127130.00000	146232.0000000	159076.000000	.000000
117	.00000	.0000000	564860.000000	568800.000000
121	1.00000	1.0000000	.000000	1.000000
125	1.00000	1.0000000	1.000000	1.000000
129	.00000	.0000000	.000000	.000000
133	.00000	.0000000	.000000	.000000
137	.00000	-.3540152	.935238	.001214
141	-.93523	-.3540172	.003266	.003484
145	.00002	.9999939	.000266	7754.000000
149	.56724	4.4225148	1441.370000	.567241
153	4.42251	1441.3700000	2287500000.000000	-2127500000.000000
157	.00000	.5672411	4.422514	1441.370000
161	.56724	4.4225148	1441.370000	2287500000.000000
165	-2127500000.00000	.0000001	568800.000000	-4553524.653260
169	-2565082.60263	3645034.59220	187.053020	-332.972450
173	-.64506	.0100000	.000100	.000000
177	.00000	.0000000	.000000	.000000
181	.00000	.0000000	.000000	.000000
185	.00000	.0000000	.000000	.000000

189	.00000	.0000000	.000000	.000000
193	.00000	.0000000	.000000	.000000
197	.00000	.0000000	.000000	.000000
201	.00000	.0000000	.000000	.000000
205	.00000	.0000000	.000000	.000000
209	.00000	.0000000	.000000	.000000
213	.00000	.0000000	.000000	.000000
217	.00000	.0000000	.000000	.000000
221	.00000	.0000000	.000000	.000000
225	.00000	.0000000	.000000	.000000
229	.00000	.0000000	.000000	.000000
233	.00000	.0000000	.000000	.000000
237	.00000	.0000000	.000000	.000000
241	.00000	.0000000	.000000	.000000
245	.00000	.0000000	.000000	.000000
249	.00000	.0000000	.000000	.000000
253	.00000	.0000000	.000000	.000000
257	.00000	.0000000	.000000	.000000
261	.00000	.0000000	******************	.333333
265	.33333	.3333333	.000000	.000000
269	.00000	.0000000	.000000	.000000
273	.00000	.0000000	.000000	.000000
277	.00000	.0000000	.000000	.000000
281	.00000	.0000000	.000000	.000000
285	.00000	.0000000	.000000	.000000
289	.00000	.0000000	.000000	.000000
293	.00000	.0000000	.000000	.000000
297	.00000	.0000000	.000000	.000000
301	.00000	.0000000	.000000	.000000
305	.00000	.0000000	.000000	.000000
309	.00000	.0000000	.000000	.000000
313	.00000	.0000000	.000000	.000000
317	.00000	.0000000	.000000	.000000
321	.00000	.0000000	.000000	.000000
325	.00000	.0000000	.000000	.000000
329	.00000	.0000000	.000000	.000000

333	.00000	.0000000	.000000	.000000
337	.00000	.0000000	.000000	.000000
341	.00000	.0000000	.000000	.000000
345	.00000	.0000000	.000000	.000000
349	.00000	.0000000	.000000	.000000
353	.00000	.0000000	.000000	.000000
357	.00000	.0000000	.000000	.000000
361	.00000	.0000000	.000000	.000000
365	.00000	.0000000	.000000	.000000
369	.00000	.0000000	.000000	.000000
373	.00000	.0000000	.000000	.000000
377	.00000	.0000000	.000000	.000000
381	.00000	.0000000	.000000	.000000
385	.00000	.0000000	.000000	.000000
389	.00000	.0000000	.000000	.000000
393	.00000	.0000000	.000000	.000000
397	.00000	.0000000	.000000	.000000
401	.00000	.0000000	.000000	.000000
405	.00000	.0000000	.000000	.000000
409	.00000	.0000000	.000000	.000000
413	.00000	.0000000	.000000	.000000
417	.00000	.0000000	.000000	.000000
421	.00000	.0000000	.000000	.000000
425	.00000	.0000000	.000000	.000000
429	.00000	.0000000	.000000	.000000
433	.00000	.0000000	.000000	.000000
437	.00000	.0000000	.000000	.000000
441	.00000	.0000000	.000000	.000000
445	.00000	.0000000	.000000	.000000
449	.00000	.0000000	.000000	.000000
453	.00000	.0000000	.000000	.000000
457	.00000	.0000000	.000000	.000000
461	.00000	.0000000	.000000	.000000
465	.00000	.0000000	.000000	.000000
469	.00000	.0000000	.000000	.000000
473	.00000	.0000000	.000000	.000000

477	.00000	.0000000	.000000	.000000
481	.00000	.0000000	.000000	.000000
485	.00000	.0000000	.000000	.000000
489	.00000	.0000000	.000000	.000000
493	.00000	.0000000	.000000	.000000
497	.00000	.0000000	.000000	.000000
501	.00000	.0000000	.000000	.000000
505	.00000	.0000000	.000000	.000000
509	.00000	.0000000	.000000	.000000
513	.00000	.0000000	.000000	.000000
517	.00000	.0000000	.000000	.000000
521	.00000	.0000000	.000000	.000000
525	.00000	.0000000	.000000	.000000
529	.00000	.0000000	.000000	.000000
533	.00000	.0000000	.000000	.000000
537	.00000	.0000000	.000000	.000000

p(14) .1327124990E+21 p(263) .1000000000E+33

the PS arry is:

1	.2992153	5.2047035	-33.100	.000000	17590.0000000	.0
7	.5645803	5.1547714	-35.250	.000341	7141.1504241	.0
13	.5646383	5.1546939	-33.750	.000341	7138.1646120	2106384288.0
19	.6035830	4.1789906	601.110	.000302	7008.0338301	.0
25	.6544608	4.1451638	-8.240	.000323	7270.4243059	.0
31	.6050335	4.1786437	62.040	.000333	6710.6063340	.0
37	.6035881	4.1789986	601.120	.000306	6788.0462115	.0
43	.4971006	4.8768606	-49.960	.000000	17590.0000000	.0
49	.6103349	4.2249140	768.620	.000290	7725.3894191	.0
55	.6103496	4.2248938	774.260	.000299	7332.0176251	.0
61	.6101816	4.2252425	756.010	.000294	7571.5320039	.0
67	.4645326	4.9157588	-51.210	.000000	17590.0000000	.0
73	.6168379	4.2433587	912.710	.000283	7803.2956764	2106406288.0
79	.6168267	4.2433562	918.710	.000283	7794.3566376	-2106406288.0
85	.3745955	5.0416976	-43.330	.000000	17590.0000000	.0
91	.2323143	2.5261339	115.950	.000336	7193.0012529	2106406288.0

97	.3861757	3.4965026	1139.750	.000310	6588.0829810	2106406288.0
103	.3765041	3.5209125	283.890	.000000	17590.0000000	.0
109	.4975638	4.8748315	-55.820	.000335	7344.0470281	-2106423296.0
115	.4975632	4.8748202	-54.450	.000335	7342.5832160	2106422288.0
121	.4961074	4.8753266	-52.430	.000000	17590.0000000	.0
127	.4926462	4.8764630	-48.880	.000000	17590.0000000	.0
133	.4926624	4.8763439	-49.490	.000000	17590.0000000	.0
139	.5802696	4.1971677	222.630	.000314	7221.1068991	.0
145	.5802820	4.1971564	223.160	.000330	6485.9974174	.0
151	.5802943	4.1971451	222.580	.000314	7221.1068991	.0
157	.6604559	4.9657226	-46.420	.000316	7921.5612712	.0
163	.6607861	4.9653001	-43.840	.000316	7917.8885281	.0
169	.6622493	4.9660868	-36.440	.000316	7909.2983500	.0
175	.5662148	4.3495560	2754.320	.000233	7607.8741794	.0
181	.5507705	4.3556756	1774.570	.000263	7381.2595483	.0
187	.5647554	4.4266819	1190.540	.000272	7856.2734341	.0
193	.5742397	4.4314054	1223.150	.000268	7965.2445119	.0
199	.5901641	4.4216345	1489.540	.000259	7973.2991496	.0
205	.5510189	4.3568515	1463.910	.000272	7475.4850394	.0
211	.5776372	4.4303587	1230.980	.000268	7956.2402784	.0
217	.5837293	4.4308308	1582.240	.000259	7845.5861607	.0
223	.4979229	4.8766213	-59.490	.000000	17590.0000000	.0
229	.4996195	4.8750054	-53.030	.000000	17590.0000000	.0
235	.6544583	4.1451807	2.050	.000323	7252.2122440	.0
241	.7060940	6.2104125	806.090	.000298	7483.0485456	2106406300.0
247	-.6218419	2.5997856	931.600	.000307	6842.9357444	2106406300.0
253	.4972965	4.8768784	-50.000	.000000	17590.0000000	.0
259	.7060810	6.2104322	808.990	.000298	7478.3237787	-2106406300.0
265	.1521840	2.9272378	27.910	.000000	17590.0000000	.0
271	-.1379960	6.0318148	23.650	.000373	6133.4508903	.0
277	-.1391469	6.0318372	109.520	.000370	6062.4725760	.0
283	.1639804	2.9230623	31.700	.000383	5786.0791052	.0
289	.1640357	2.9231244	11.380	.000383	5827.0476282	.0
295	-.1388379	6.0331309	528.370	.000354	5706.2905396	2106406300.0
301	-.5785941	5.0498245	706.610	.000313	6978.4058649	2106406300.0
307	.6806490	4.9420411	4.000	.000312	8011.8500266	-2106406300.0

313	-.6179352	2.6002396	655.300	.000307	7334.4317140	-2106406300.0
319	.6032859	4.1800334	570.870	.000302	7560.0529505	-2106406300.0
325	.0000000	.0000000	.000	.000000	.0000000	.0
331	.0000000	.0000000	.000	.000000	.0000000	.0
337	.0000000	.0000000	.000	.000000	.0000000	.0
343	.0000000	.0000000	.000	.000000	.0000000	.0
349	.0000000	.0000000	.000	.000000	.0000000	.0
355	.0000000	.0000000	.000	.000000	.0000000	.0
361	.6089720	-2.0578779	646.340	.609298	-2.0572374	641.0
367	.0000000	17590.0000000	4.157	4.158022	.0000000	.0

7.2.3 Execution Procedure

Normal setup of the production directory will copy the current version of the CLEAR5 program into the production directory. Execution is accomplished by entering:

```
clear5.x
```

and return.

Run time is about 2 seconds.

7.2.4 Messages

There are no messages other than the interactive comments.

8.0 COMPLEARS

8.1 COMPLEARS FUNCTIONAL DESCRIPTION

This is a utility program that computes the difference between position, velocity, and acceleration in the state vector of two filter output files and creates two files containing these differences. One of the output files is used for plotting these differences and the other is formatted for tabular printout.

8.2 COMPLEARS OPERATIONAL DESCRIPTION

The state vectors of the two files to be compared are read until the time tags of the two datum points are equal. When they are equal, the differences between the respective nine elements containing the position, velocity, and acceleration are computed. The magnitude of the position, velocity, and acceleration differences are then computed. The time tag, differences, and each magnitude are written into the output files.

8.2.1 Equipment Configuration

There is no special equipment configuration required to execute this utility program. All that is required is the standard configuration required for the Ascent/Descent production procedure.

8.2.2 Input Items

The input consists of the names of the two filter output files whose position, velocity, and acceleration differences of their states are desired.

8.2.2.1 Sample Input

The input files are binary files produced by the program LRBET5 (see Section 22.0).

8.2.2.2 Definition of Inputs

The following elements of the LRBET5 output state vector are used:

X(1,2,3)	Position
X(4,5,6)	Velocity
X(25,26,27)	Acceleration.

8.2.3 Execution Procedure

The program is located in the directory

/data1/Adprodct/Utilities

It is interactive and can be executed from the Adprodct directory by typing in and executing

/Utilities/complears.x

The terminal will respond with

"input the prime file name"

When the name of that file has been entered, the file will be read and the terminal will respond with

"input the 2nd file name"

When that name has been entered, that file will be read and the program will execute until an End Of File of either of the files has been reached. At the conclusion of program execution, the $-prompt will reappear on the screen.

For a Descent analysis, COMPLEARS takes about nine minutes to execute. The execution time for a Ascent analysis will be less than this.

8.2.3.1 Sample Output

8.2.3.1.1 Plot File, PLTFILE

This file is a binary file, so no example of it can be shown.

8.2.3.1.2 Tabular Printout File, LEARDIFS

564860.000	-.107912E+02	-.933080E+02	.977633E+01
	.595140E-01	-.915206E-03	-.163103E-01
	.319645E+05	-.492225E+04	-.374938E+02
	.944374E+02	.617153E-01	.323413E+05
564861.000	-.107317E+02	-.933089E+02	.976003E+01
	.595111E-01	-.778589E-03	-.162970E-01
	.317653E+05	-.489819E+04	-.372738E+02
	.944297E+02	.617071E-01	.321408E+05
564862.000	-.106722E+02	-.933096E+02	.974374E+01
	.595079E-01	-.641955E-03	-.162835E-01
	.315661E+05	-.487438E+04	-.370538E+02
	.944220E+02	.616989E-01	.319402E+05
564863.000	-.106127E+02	-.933102E+02	.972746E+01
	.595044E-01	-.505304E-03	-.162700E-01
	.313667E+05	-.485081E+04	-.368337E+02
	.944142E+02	.616907E-01	.317396E+05
564864.000	-.105532E+02	-.933106E+02	.971120E+01
	.595007E-01	-.368638E-03	-.162563E-01

	.311673E+05	-.482750E+04	-.366136E+02
	.944063E+02	.616826E-01	.315389E+05
564865.000	-.104937E+02	-.933109E+02	.969495E+01
	.594967E-01	-.231956E-03	-.162426E-01
	.309678E+05	-.480443E+04	-.363935E+02
	.943983E+02	.616745E-01	.313383E+05

8.2.3.2 Definition of Outputs

The following variables are written into both output files, that for the tabular printout (LEARDIFS) and that for plotting (PLTFILE).

T Time tag of datum point

DIFF The actual differences between the prime and second states

DIFF(1,2,3) = position

DIFF(4,5,6) = velocity

DIFF(7,8,9) = acceleration

RAD The magnitude of the position difference

VEL The magnitude of the velocity difference

ACC The magnitude of the acceleration difference

8.2.4 Messages

None other than the interactive response messages concerned with input files.

9.0 EDITIMUBEA

9.1 EDITIMUBEA FUNCTIONAL DESCRIPTION

This program is interactive. The purpose of the program is to edit the IMU file (TAPE10) or the bea file (BEADATA) and replace bad data points with substituted data or eliminate the point altogether. The program asks for the file name to be edited, the type of data, and the time of the bad data point. If the data type is IMU, the bad data point can be eliminated or substituted with the average of the other two IMU reading, or replaced with one of the IMU readings, or replaced with numbers inserted from the keyboard. If the type of data is BEA, the bad data point may be eliminated and substituted with the mid point BEA reading of the past BEA data point and the next BEA data point. The following specific functions are accomplished by EDITIMUBEA:

(1) Request the file name to be edited.

(2) Request the data type.

(3) Request the time of the first edit point.

(4) Open and read the input file up to the time of the edit.

(5) Write the output file with all the same data as was read up to the edit data point.

(6) Request user information on how to process the record.

(7) If BEA data, the record is replaced with the interpolated BEA measurement between the past record and the next record.

(8) If IMU data, the program requests which IMU element to edit.

(9) Request instructions on how the element is to be replaced (average the

other two elements,replace with one of the other elements, or substitute a number from the keyboard).

(10) Perform the requested substitution.

(11) Request another IMU/BEA data edit time.

(12) Repeat the process from step 5 to 11 until an end of file is reached.

9.2 EDITIMUBEA OPERATIONAL DESCRIPTION

EDITIMUBEA is one of the Ascent/Descent configured programs and resides in /users/Adheaven/EXECUTE. The program is normally used in the shell script, QAIMU, to eliminate the last two records on the TAPE10 (two large numbers). The program is not normally used for other processing. Occasionally, the program is used primarily to correct bad IMU/BEA data that are not corrected with the automatic editing done in TELMTR. Normally no editing is required after the automatic editing done in TELMTR except in special rare cases. In such circumstances, the process is quite useful.

9.2.1 Equipment Configuration

The program may be executed in any directory provided the input files are identified with their correct "PATH". The input files are BEADATA or TAPE10. The output file has the name entered by the user and follows the format of the IMU file (TAPE10) or the BEA file (BEADATA). The output file contains the edited form of the file. Since no print file is kept of the changes made through this process it is a good idea to turn on "log bottom" for the internal printer to get a permanent record.

9.2.2 Input Items

9.2.2.1 Sample Input

There are no formatted inputs. Interactive statements are discussed in the execution procedure below.

9.2.2.2 Definition of Inputs

9.2.2.2.1 TAPE10:

This file is a binary file of the IMU sensed acceleration for each IMU in Mean-of-50 coordinates. The start and stop times of the file are as defined by the start and stop times in TELMTR.IN. The final two times in the file are 1.0d38 to flag the end of the file to LRBET5. TAPE 10 consists of multiple records, each record containing eleven double precision words in the following order:

dp word 1: Time of the IMU measurement in seconds from midnight day of launch,

dp word 2: Delta time, the difference in time from the last measurement to the current measurement.

dp word 3: X component of sensed acceleration for IMU1 (in m/sec/sec)

dp word 4: Y component of sensed acceleration for IMU1 (in m/sec/sec)

dp word 5: Z component of sensed acceleration for IMU1 (in m/sec/sec)

dp word 6: X component of sensed acceleration for IMU2 (in m/sec/sec)

dp word 7: Y component of sensed acceleration for IMU2 (in m/sec/sec)

dp word 8: Z component of sensed acceleration for IMU2 (in m/sec/sec) dp word 9: X component of sensed acceleration for IMU3 (in m/sec/sec)

dp word 10: Y component of sensed acceleration for IMU3 (in m/sec/sec)

dp word 11: Z component of sensed acceleration for IMU3 (in m/sec/sec)

BEADATA:

BEADATA is the primary binary output from RUNBEA. It is composed of multiple records in the following format:

(1) Time (double precision) - The time of the stable member to outer roll quaternion in seconds from midnight day of launch.

(2) IOPTV (integer) - User option selection currently in use at this time. (See Section 40.0, RUNBEA, for further details.)

(3) ISTAT (integer) - Selected status of the best estimate quaternion. (See Section 40.0, RUNBEA, for further details.)

(4) BEQ (4 double precision words) - The Best Estimate Quaternian for the transformation from Mean-of-50 to body axis coordinates.

9.2.3 Execution Procedure

Normal setup of the production directory will copy the current version of the executable EDITIMUBEA program. Execution is accomplished by typing in and executing

```
editimubea.x
```

The following interactive requests will be presented by the program:

"EDITIMUBEA program Version 3.2 -- Jun 04, 1985"

This is the identifier header and no response is necessary by the user.

"Enter input file name"

This request is for the file name of the input file. Normally the file will be either TAPE10 or BEADATA. Note that with this entry the user is not restricted to execute the program in the production directory since the full PATH to the file may be used.

"Enter data type -- imu or bea"

This request is for the type of data that will be edited, either IMU or BEA type data. Entry of the "imu" or "bea" is requested. Failure to enter either "imu" or "bea" will cause undetermined reaction by the program.

"Enter output file name"

This is a request for the file name of the output file. Remember that the input and output file names cannot be the same if they are in the same directory.

"Enter the timetag of the bad quat or imu"

This request is for the time tag of the record that the user wishes to edit. The tolerance on the time tag is plus or minus 0.005 seconds. An error in time by more than 0.005 seconds causes the program to bypass the time requested and just rewrite the file as it was. If multiple edits are contemplated, then the earliest time should be entered first.

If the IMU is selected, the following request appears:

"Do you want to compute new delta time ? y/n"

This request is to recompute the delta time in the IMU records. Occasionally, this is necessary when deletion of a record is made or when a gapfill is attempted.

"FILE BEING READ AND PROCESSED
Hold on to your seat and be patient"

This comment is presented when the program begins to process the data to find the first record to change. The input file is copied to the output file during this time.

"Do you want to discard this record ? y/n"

This request is to allow rejection of a totally bad record at the time requested. A "y" response will force the BEA data to be interpolated at the time of the record using the previous record BEA data and the next record of bea data. A "y" response will delete the record when the data is IMU data and a gap in IMU data will result. In addition, the following message will occur:

"DATA RECORD HAS BEEN DISCARDED *******"

An "n" response continues processing of the IMU specific changes desired.

"Enter imu to be edited, imux1,imuy1,...imuz3"

This request is for the IMU element the user wishes to change. Each IMU (1,2,3) has three elements (x,y,z). The entry identifies both the IMU number and the element of that IMU.

"Enter a to average the other two imu elements
Enter good imu to replace the bad imu, imux1,...,imuz3
OR enter the value to replace the bad one"

This asks the user how to handle the bad IMU. If the user inserts an "a" then the program averages the other IMU values for the same element and puts the average into the bad IMU value. If the user inserts a specific IMU element (eg., IMUy2) then the value of that element replaces the chosen bad IMU element. If a number is inserted, then the number replaces the chosen bad IMU value. The following responses will result from these selections by the user:

EXAMPLE: Suppose a bad IMU value, say IMUy2, was entered.

If the user selects "a" then the response is: "imuy2 has been replaced by averaging"

If the user selects "imuy1" then the response is: "imuy2 has been replaced by xxxxxxx", where xxxxxxx is the value of imuy1

If the user selects ".00234" then the response is: "imuy2 has been replaced be .0023400"

"Enter imu to be edited, imux1,imuy1,...imuz3"

Returns with the same meaning in case another change is required. In order to step to a new time, a <CR> is required to exit.

"More imu element to be edited? y/n"

This request allows the next IMU element to be updated. Looping will continue with this record until the answer is "n". After a "n" answer, the following messages will be written:

"WRITTING EDITED DATA $$$$$$$$$$$$$$$$$"
Bad quat or imu had been replaced"

At this time the cycle of edits repeats. Termiation of the program is accomplished by inserting a large time (eg.,1d38). The following statements will occur when the large number is inserted for the time:

"End of file encountered while reading input file
EDITIMUBEA Program -- Normal termination"

9.2.4 Messages

The following error messages may occur in the process of execution of this program:

"Error occurred while reading the input file

Abnormal termination -- Try again"

This error message will occur if there is an IO error in reading the input file. Suggest reexecuting the program.

(2) "WRONG CHOICE !!! TRY AGAIN"

This error message will occur if a selection of the bad IMU was not of the form "imu" concatenated with the element (eg.,x,y,z) and concatenated with the IMU number (eg.,1,2,3). In any event, no harm is done; insert the correct bad IMU format.

10.0 EDITMSBLS

10.1 FUNCTIONAL DESCRIPTION

EDITMSBLS reads in a msbls data file ("tape16", "tape17", or "tape18") and copies the data to a user specified name. In the process, EDITMSBLS allows the user to delete a single record with the specified time tag.

10.2 OPERATIONAL DESCRIPTION

EDITMSBLS is used only if msbls data are available.

10.2.1 Equipment Configuration

EDITMSBLS requires the standard Ascent/Descent hardware configuration.

10.2.2 Input Items

The program is interactive and requires only user response to a series of prompts. The first prompt is

"Enter input file name"

The next prompt is

"Enter output file name"

The next prompt is

"Enter the timetag of the msbls file"

10.2.3 Execution Procedure

To execute EDITMSBLS, the user must type in:

```
editmsbls.x
```

Before running EDITMSBLS, the user must have run MSBLS.

10.2.3.1 Sample Output

The output is the same as the input with the one record deleted. Both input and output are binary.

10.2.4 Messages

When the end of file is reached, the program displays a message saying so and then displays a message:

"EDITMSBLS Program -- Normal termination"

If an error occurs while reading the input file, an error message is displayed.

11.0 FICHOUT

11.1 FICHOUT FUNCTIONAL DESCRIPTION

The program FICHOUT builds a tape which is used to create a microfiche. The microfiche tapes are a part of the Ascent/Descent BET output products. The two files which are made into microfiches are "opipfiche" and "navprt". FICHOUT reads a file specified by the user and writes it to a tape. The data is formatted to be readable by the microfiche machine.

11.2 FICHOUT OPERATIONAL DESCRIPTION

There are no special conditions on the operation of FICHOUT.

11.2.1 Equipment Configuration

The standard Ascent/Descent hardware configuration is required. A magnetic tape with a write ring on must be mounted on the tape drive.

11.2.2 Input Items

The program FICHOUT prompts the user for the output file name, the tape drive to use, and the number of the first reel. The program will read the file specified by the user, either opipfiche or navprt.

11.2.2.1 Sample Input

The files "opipfiche" and "navprt" are described in OPIP (Section 29.0) and I2IIPC (Section 18), sections, respectively. The program is interactive. When run FICHOUT gives the following prompts

ENTER NAME OF INPUT FILE

to which the user responds with either "opipfiche" or "navprt". The next prompt is

```
ENTER TAPE UNIT NO. - (1,2, OR 3)
1. UNIT 0 (1600 BPI)
2. UNIT 1 (1600 BPI)
3. UNIT 1 (6250 BPI)
```

The user must respond with appropriate tape unit number.

The next prompt is

```
ENTER STARTING REEL NO.
```

This entry tells the program which reel to begin with. If, for example, there are 8 reels and an error occurred in the 4th reel, causing the need to rerun FICHOUT, the user may start with reel 4. The normal start is 1.

11.2.2.2 Definition of Inputs

The input file name is either "opipfiche" or "navprt".

1. UNIT 0 (1600 BPI) - this selects the device /dev/tape0
2. UNIT 1 (1600 BPI) - this selects the device /dev/tape1
3. UNIT 2 (6250 BPI) - this selects the device /dev/tape2

The starting reel number is usually 1. However, the "opipfiche" file usually takes about six reels of tape. At the end of each reel, the program prompts again for unit number. If the program should terminate unexpectedly, the program could be run again entering the number of the reel which was mounted at the time of termination.

11.2.3 Execution Procedure

Type in and execute

```
fichout.x
```

11.2.3.1 Sample Output

The program copies the input data to a tape and therefore, the output is the same as the input.

11.2.4 Messages

Upon normal termination, FICHOUT displays the number of pages, and the number of records written to the tape. If the user enters a bad unit number when prompted, a message is displayed and the user is prompted for another unit number.

12.0 GTRACK

12.1 GTRACK FUNCTIONAL DESCRIPTION

After the onboard state vector tape is received and translated into HP format, the timetags and position vectors are sent into the program GTRACK. This program converts the onboard position vectors from Mean of 1950 coordinates to Geodetic coordinates whose components are latitude, longitude, and altitude.

12.2 GTRACK OPERATIONAL DESCRIPTION

12.2.1 Equipment Configuration

GTRACK uses the standard Ascent/Descent hardware.

12.2.2 Input Items

The inputs necessary to run this program are in the file "gtrack.in" and "obdata".

12.2.2.1 Sample Input

GTRACK has no input other than its execution command and the input data files, "gtrack.in" and "obdata", which are binary files.

12.2.2.2 Definition of inputs

There are no inputs except the input data files, obdata and gtrack.in

obdata format:

The onboard state file, "obdata", is a sequential binary file (unformatted) written with fortran write statements. The file contains one header record followed by data records at the rate of one data record for each time tag. The records contain

intdum - dummy variable not used in GTRACK
    integer intdum

dummy - dummy variable not used in GTRACK
    double precision dummy

time - the onboard state time tag in seconds from December 31
    double precision time

state - the onboard position vector in mean of 50 coordinates and in feet
    double precision state(3)

gtrack.in format:

The file "gtrack.in" is a sequential binary file (unformatted) written with a fortran write statement and contains only one record. The variables and a brief description are listed below:

rnp - the 3 x 3 rotation, nutation, and precession transformation matrix.
    double precision rnp(3,3)

start - the time at which the program is to start using the input mean of 50 vectors. The time is measured in seconds from December 31.
    double precision start

stp - the time at which to stop using the input vectors. The time is measured in seconds from December 31.
    double precision stp

debug - debugging flag true if debug print is desired this flag is set to 1, otherwise it is set to 0.
    integer debug

yearln - the year of the launch

```
    integer yearln
eprnp   - the epoch of the rnp matrix.  Measured in days from
          December 31 of the previous year.
    double precision eprnp
```

12.2.3 Execution Procedure

In order to run GTRACK, the program INPUTS, which creates the file "gtrack.in", must first be run and the onboard state tape must be read in. To run GTRACK type in and execute

gtrack.x

12.2.3.1 Output Items

The output of GTRACK is the file "gtrack66" which is an ASCII file and may be printed out. The printout contains the RNP matrix and a check on the orthoganality of the matrix,

rnp * (rnp-transpose) - identity-matrix

In table format is the year of the launch, the day of the year (Jan 1 is day one), the number of seconds that have elapsed in the given day, latitude in degrees, longitude in degrees, and the altitude in feet.

12.2.4 Messages

Upon normal termination, no messages are displayed. If an error occurred the inputs file should be checked for incorrect data.

13.0 HP2CY

13.1 HP2CY FUNCTIONAL DISCRIPTION

The program HP2CY copies an HP binary file onto a tape as a CDC cyber binary file. The program converts the file "finaldata". The output of this program is part of the Ascent/Descent BET output product.

13.2 HP2CY OPERATIONAL DESCRIPTION

13.2.1 Equipment Configuration

The standard Ascent/Descent Hardware configuration is used. One magnetic tape with write ring needs to be mounted on the tape drive.

13.2.2 Input Items

The input to HP2CY is the file "finaldata" which is a file with four records of data, as described in the Ascent/Descent BET requirements (document 1, Section 2.1), blocked together in one record. The program runs interactively and therefore some of the inputs are entered by the user.

12.2.2.1 Sample Input

When run the program gives the following prompt

```
SELECT TAPE UNIT - ENTER (1,2,or 3 )
1. UNIT 0 (1600 BPI)
2. UNIT 1 (1600 BPI)
3. UNIT 2 (6250 BPI)
```

13.2.2.2 Definition of Inputs

1. UNIT 0 (1600 BPI) - this selects the device /dev/tape0
2. UNIT 1 (1600 BPI) - this selects the device /dev/tape1
3. UNIT 2 (6250 BPI) - this selects the device /dev/tape2

13.2.3 Execution Procedure

In order to run HP2CY, the user should make sure a magnetic tape with write ring is mounted on the tape drive. Then type in

hp2cy.x

13.2.3.1 Sample Output

HP2CY converts the input data to Cyber format and therefore the output is the same as the input. It also creates a print file called

hp2cy66

13.2.4 Messages

HP2CY displays the number of records written on the tape upon normal termination. When selecting the tape drive, the program displays an error message if an illegal unit number is entered.

14.0 HP2UNV

14.1 HP2UNV FUNCTIONAL DISCRIPTION

The program HP2UNV copies an HP binary file onto a tape as a Univac binary file. The program converts the file "finaldata". The tape created by HP2UNV is part of the Ascent/Descent BET output product.

14.2 HP2UNV OPERATIONAL DESCRIPTION

14.2.1 Equipment Configuration

The standard Ascent/Descent Hardware configuration is used. One magnetic tape with write ring needs to be mounted on the tape drive.

14.2.2 Input Items

The file "finaldata" is composed of one thousand double precision word blocks where each block consists of four logical records. A description of the records is given in the Ascent/Descent BET requirements document (document 1, Section 2.1).

14.2.2.1 Sample Input

When run the program gives the following prompt

```
SELECT TAPE UNIT - ENTER (1,2,or 3 )
1. UNIT 0 (1600 BPI)
2. UNIT 1 (1600 BPI)
3. UNIT 2 (6250 BPI)
```

14.2.2.2 Definition of Inputs

1. UNIT 0 (1600 BPI) - this selects the device /dev/tape0
2. UNIT 1 (1600 BPI) - this selects the device /dev/tape1
3. UNIT 2 (6250 BPI) - this selects the device /dev/tape2

14.2.3 Execution Procedure

In order to run HP2UNV, the user must mount a magnetic tape with a write ring on the tape drive. Then the user types in and executes

hp2unv.x

14.2.3.1 Sample Output

HP2UNV converts the input data into Univac format. Therefore the output looks the same as the input. It also creates a print file called "hp2unv66"

14.2.4 Messages

HP2UNV displays the number of records written on the tape upon normal termination. When selecting the tape drive, the program displays an error message if an illegal unit number is entered.

15.0 HPMET

15.1 HPMET FUNCTIONAL DISCRIPTION

The program HPMET reads the meteorological data tape and creates an ASCII file called "met". The meteorological data tape is in ASCII format and contains weather information around the launch pad on ascent or the runway on descent.

15.2 HPMET OPERATIONAL DESCRIPTION

15.2.1 Equipment Configuration

The standard Ascent/Descent Hardware configuration is used. The magnetic tape with the meteorological data on it must be mounted on the tape drive.

15.2.2 Input Items

Input consist of user response to prompts and the meteorological input data.

15.2.2.1 Sample Input

The program runs interactively. In order to get started, the program asks

```
SELECT TAPE UNIT - ENTER (1,2,or 3 )
1. UNIT 0 (1600 BPI)
2. UNIT 1 (1600 BPI)
3. UNIT 2 (6250 BPI)
```

The user must respond with a 1, 2, or 3.

The meteorological tape is as follows:

STS61C

LAUNCH DATE 860112 1155Z

FLIGHT AZIMUTH 90.00

60FT NW PLP WS=15.4FPS WD=323

275FT NW FSS WS=18.6FPS WD=342

SURFACE PRESSURE 1021.3 MB

.28500000+02	.80600000+02	-.99990000+04	-.99990000+04
.21000000+02	.10000000+02	.32000000+03	.12000000+02
.10206000+04	.12414043+04	.94000000+01	.10003200+01
.10225598+01	.24849275+01	.70000000+01	-.99990000+04
-.99990000+04	.49000000+02	-.99990000+04	-.99990000+04
.28500000+02	.80600000+02	-.99990000+04	-.99990000+04
.10000000+03	.16000000+02	.33000000+03	.12250153+02
.10177110+04	.12368076+04	.93515832+01	.10015240+01
.10270169+01	.24836680+01	.70000000+01	-.99990000+04
-.99990000+04	.29000000+02	-.99990000+04	-.99990000+04
.28500000+02	.80600000+02	-.99990000+04	-.99990000+04
.20000000+03	.17000000+02	.34000000+03	.12566803+02
.10140658+04	.12310148+04	.92902962+01	.10030480+01
.10326110+01	.24820410+01	.70000000+01	-.99990000+04
-.99990000+04	.28000000+02	-.99990000+04	-.99990000+04
.28500000+02	.80600000+02	-.99990000+04	-.99990000+04
.30000000+03	.18000000+02	.35500000+03	.12883452+02
.10104336+04	.12252505+04	.92290093+01	.10045720+01
.10381518+01	.24803776+01	.70000000+01	-.99990000+04
-.99990000+04	.26000000+02	-.99990000+04	-.99990000+04
.28500000+02	.80600000+02	-.99990000+04	-.99990000+04
.40000000+03	.17000000+02	.18000000+02	.13200102+02
.10068144+04	.12195149+04	.91677222+01	.10060960+01
.10436397+01	.24786786+01	.70000000+01	-.99990000+04
-.99990000+04	.28000000+02	-.99990000+04	-.99990000+04

.28500000+02	.80600000+02	-.99990000+04	-.99990000+04
.50000000+03	.20000000+02	.22000000+02	.13516752+02
.10032082+04	.12138075+04	.91064352+01	.10076200+01
.10490749+01	.24769440+01	.80000000+01	-.99990000+04
-.99990000+04	.24000000+02	-.99990000+04	-.99990000+04
.28500000+02	.80600000+02	-.99990000+04	-.99990000+04
.60000000+03	.21000000+02	.24000000+02	.13833401+02
.99961494+03	.12081283+04	.90451481+01	.10091440+01
.10544578+01	.24751746+01	.80000000+01	-.99990000+04
-.99990000+04	.23000000+02	-.99990000+04	-.99990000+04

15.2.2.2 Definition of Inputs

The interactive inputs are as follows

1. UNIT 0 (1600 BPI) - this selects the device /dev/tape0
2. UNIT 1 (1600 BPI) - this selects the device /dev/tape1
3. UNIT 2 (6250 BPI) - this selects the device /dev/tape2

The first six lines of the meteorological tape are a header. The data is grouped into records with five lines per record. Each record (shown above, sequentially left to right) consists of:

field #	description
1	latitude
2	longitude
3	spare
4	flag
5	geometric altitude
6	horizontal wind speed
7	horizontal wind direction
8	temperature
9	pressure
10	density
11	dew point

12	temperature uncertainty
13	pressure uncertainty
14	density uncertainty
15	horizontal wind speed system uncertainty
16	horizontal wind speed noise uncertainty
17	vertical wind speed system uncertainty
18	horizontal wind direction system uncertainty
19	horizontal wind direction noise uncertainty
20	spare

15.2.3 Execution Procedure

In order to run HPMET, the meteorological tape must be mounted on the tape drive. The user then types in

```
hpmet.x
```

15.2.3.1 Sample Output

HPMET copies the data on the tape to a file "met", so the input is identical to the output.

15.2.4 Messages

Upon successful termination HPMET displays the number of records processed, which is the number of records on the meteorological tape.

C-2

16.0 HPNAV2CY

16.1 HPNAV2CY FUNCTIONAL DISCRIPTION

The program HPNAV2CY copies an HP binary file onto a tape as a CDC cyber binary file. The program converts the file "navblk". The tape created by HPNAV2CY is part of the Ascent/Descent BET output product.

16.2 HPNAV2CY OPERATIONAL DESCRIPTION

16.2.1 Equipment Configuration

The standard Ascent/Descent Hardware configuration is used. One magnetic tape with write ring needs to be mounted on the tape drive.

16.2.2 Input Items

The file "navblk" is described in the Ascent/Descent BET requirements document (document 1, Section 2.1).

16.2.2.1 Sample Input

The program reads the binary file "navblk". The programs runs interactively. When run the program gives the following prompt

```
SELECT TAPE UNIT - ENTER (1,2,or 3 )
1. UNIT 0 (1600 BPI)
2. UNIT 1 (1600 BPI)
3. UNIT 2 (6250 BPI)
```

The user must respond with a 1, 2, or 3.

16.2.2.2 Definition of Inputs

1. UNIT 0 (1600 BPI) - this selects the device /dev/tape0
2. UNIT 1 (1600 BPI) - this selects the device /dev/tape1
3. UNIT 2 (6250 BPI) - this selects the device /dev/tape2

16.2.3 Execution Procedure

In order to run HPNAV2CY, a magnetic tape with a write ring must be mounted on the tape drive. I2IIPC must be run first. The user then types in and executes

hpnav2cy.x

16.2.3.1 Sample Output

HPNAV2CY copies the file "navblk" to tape, so the output looks the same as the input. HPNAV2CY creates a print file called "cybnav66"

16.2.4 Messages

Upon normal termination, the program displays the number of records written to the tape. If the user enters a bad tape unit number, the program prompts the user for another unit.

17.0 HPNAV2UNV

17.1 HPNAV2UNV FUNCTIONAL DISCRIPTION

The program HPNAV2UNV copies an HP binary file onto a tape as a Univac binary file. The program converts the file "navblk". The tape created by HPNAV2UNV is part of the Ascent/Descent BET output product.

17.2 HPNAV2UNV OPERATIONAL DESCRIPTION

17.2.1 Equipment Configuration

The standard Ascent/Descent Hardware configuration is used. One magnetic tape with write ring needs to be mounted on the tape drive.

17.2.2 Input Items

For a description of the file "navblk" please refer to the Ascent/Descent BET requirements (document 1, Section 2.1).

17.2.2.1 Sample Input

The programs reads the binary file "navblk". The program runs interactively. When run the program gives the following prompt

```
SELECT TAPE UNIT - ENTER (1,2,or 3 )
1. UNIT 0 (1600 BPI)
2. UNIT 1 (1600 BPI)
3. UNIT 2 (6250 BPI)
```

The user must respond witha 1, 2, or 3.

17.2.2.2 Definition of Inputs

1. UNIT 0 (1600 BPI) - this selects the device /dev/tape0
2. UNIT 1 (1600 BPI) - this selects the device /dev/tape1
3. UNIT 2 (6250 BPI) - this selects the device /dev/tape2

17.2.3 Execution Procedure

In order to run HPNAV2UNV, a magnetic tape with a write ring must be mounted; the user then types in and executes

hpnav2unv.x

17.2.3.1 Sample Output

The program copies the file "navblk", so the output looks the same as the input. The program writes to a print file "unvnav66"

17.2.4 Messages

Upon normal termination, the program displays the number of records written to the tape. If the user enters a bad tape unit number, the program prompts the user for another unit.

18.0 I2IIPC

18.1 I2IIPC FUNCTIONAL DESCRIPTION

The program I2IIPC reads the meteorological data as well as information on the radar station locations and then forms the files "navprt" and "navblk" which are delivered as part of the output product. The file "navprt" is an ASCII file which is used to create a microfiche, the file "navblk" is a binary file with the same data on it.

18.2 I2IIPC OPERATIONAL DESCRIPTION

18.2.1 Equipment Configuration

The standard Ascent/Descent equipment configuration is required.

18.2.2 Input Items

There are no inputs except the input data files.

18.2.2.1 Sample Input

The files "met" and "i2iipc.in" are the inputs. Both files are binary, so no listings are available.

18.2.2.2 Definition of Inputs

The meteorological data is in the file "met" and consists of between one and four totems. Each totem contains meteorological data about a particular latitude and longitude at various altitudes. The data is as follows

latitude
longitude
flag
spare
altitude
horizontal wind speed
horizontal wind direction
tempreture
pressure
density
dew point
temp uncertainty
pressure uncertainty
density uncertainty
hor wind speed uncertainty
hor wind direct uncertainty
vertical wind speed uncertainty
wind direct uncertainty system
wind direct uncertainty noise
spare

The file i2iipc.in contains the following

description	dimension
guidance release times	4
center of gravity	4.200
special event time	200
refsmat data	27
tracker location data	6,100
srb ignition time	1
earth fixed flight direct	1
lat of launch site	1
ang launch site/equator	1
long of launch site	1

earth radius to nav base	1
height of nav base	1
ref pos of nav base	3

18.2.3 Execution Procedure

In order to run I2IIPC, QAMETGRAPH must be run first. To execute the program type in and execute

```
i2iipc.x
```

18.2.3.1 Sample Output

The file "navblk" is binary, however the same information is in both "navblk" and "navprt".

18.2.4 Messages

None.

19.0 ILD

19.1 ILD FUNCTIONAL DESCRIPTION

ILD converts the I-load data tape to a format that can be used by the HP-9000. The I-load data tapes are delivered as IBM EBCDIC data, therefore the data must be converted to ASCII format in order to be usable.

19.2 ILD OPERATIONAL DESCRIPTION

This program is interactive and reads from the tape drive. It outputs to the file "msid".

19.2.1 Equipment Configuration

The standard Ascent/Descent equipment configuration is required. One magnetic tape drive is needed with the I-load data tape mounted on it.

19.2.2 Input Items

The input consists only of data extracted from the I-load tape and the user's response to a single query.

19.2.2.1 Sample Input

The input to the program is from the magnetic tape containing the I-load data. The program runs interactively. When run the program gives the following prompt

```
SELECT TAPE UNIT - ENTER (1,2,or 3 )
1. UNIT 0 (1600 BPI)
```

2. UNIT 1 (1600 BPI)
3. UNIT 2 (6250 BPI)

The user could must respond with 1, 2, or 3.

19.2.2.2 Definition of Inputs

1. UNIT 0 (1600 BPI) - this selects the device /dev/tape0
2. UNIT 1 (1600 BPI) - this selects the device /dev/tape1
3. UNIT 2 (6250 BPI) - this selects the device /dev/tape2

19.2.3 Execution Procedure

To execute the program type in and execute

ild.x

19.2.3.1 Sample Output

The following is the file "msid"

```
V96U7096C
+9.829565E-01
V96U7097C
+4.363323E-04
V96U7098C
-1.838379E-01
V96U7099C
-4.529508E-04
V96U7100C
+9.999999E-01
V96U7101C
-4.84048E-05
V96U7102C
```

+1.838379E-01
V96U7103C
+1.308493E-04
V96U7104C
+9.829566E-01
V96U7132C
+1.0E+00
V96U7133C
+9.9999917E-01
V96U7134C
+9.999963E-01
V96U7135C
+0.0E+00
V96U7136C
+1.2846811E-03
V96U7137C
+2.7191528E-03
V96U7138C
+0.0E+00
V96U7139C
-1.0429627E-05
V96U7140C
-2.5404638E-06
V96U7141C
+0.0E+00
V96U7142C
-1.2846809E-03
V96U7143C
-2.7191527E-03
V96U7144C
+1.0E+00
V96U7145C
+9.9999917E-01
V96U7146C
+9.999963E-01
V96U7147C

+0.0E+00
V96U7148C
+1.1254387E-05
V96U7149C
+1.7952232E-05
V96U7150C
+0.0E+00
V96U7151C
+1.0444075E-05
V96U7152C
+2.5892682E-06
V96U7153C
+0.0E+00
V96U7154C
-1.1240979E-05
V96U7155C
-1.7945258E-05
V96U7156C
+1.0E+00
V96U7157C
+1.0E+00
V96U7158C
+1.0E+00
V97U4413C
+9.820068E-02
V97U4414C
-4.6616053E-01
V97U4415C
-8.7923318E-01
V97U4429C
+5.9689E+04
+5.7892304E+04
+7.32417E+03
+5.7892304E+04
+5.9689E+04
V97U5749C

-2.4E+00
V97U5750C
+4.9931115E-01
V97U5751C
-1.40680677E+00
V99U9559C
-1.6357614E-03
V99U9560C
-1.024896E-03
V99U9561C
-1.9683437E-05
V99U9562C
+7.0201021E-04
V99U9563C
+3.3907867E-03
V99U9564C
-1.5368594E-05

19.2.4 Messages

None.

20.0 INPUT

20.1 INPUT FUNCTIONAL DESCRIPTION

INPUT is interactive and provides the major source of input data for the Ascent/Descent process. This program reads 17 default files containing data that approximates the necessary data to execute the ascent/descent process. The user then is allowed to update and/or modify the default data as required to set the data correctly for a specific flight's execution. The user is made aware of his progress in the update process through menu updates. When the data for the mission has been properly entered for a specific update session, the program closes the input files and executes processing to generate 18 files used for input to the necessary programs for the Ascent/Descent process. The basic functions of this program are as follows:

(1) Read the default files in the directory.

(2) Generate menus for the user to select to update data sets.

(3) After user selection of a set of data to update, the user is presented with a menu of the data and instructions on how to update the data.

(4) After the user has updated the data via a selected menu, the main menu is returned to the user for another selection.

(5) After the final update of a session, the program reads all input files and generates the output files, which become the input files to the various programs of the Ascent/Descent process.

(6) Many subfunctions are accomplished in this final generation of output files, such as:

   (a) Initialize data variables

   (b) Read the I-load data for initialization

(c) Calculate IMU transformations

(d) Calculate special manually entered refraction coefficients

(e) Read runway and radar files of standard data

(f) Calculate the RNP matrix

(g) Calculate Mean-of-50 Launch/Landing coordinates

(h) Calculate the CG data to a common coordinate system

20.2 INPUT OPERATIONAL DESCRIPTION

The normal setup of a flight production directory will preload the defalut files necessary to run the program. Execution should occur in the production directory.

20.2.1 Equipment Configuration

There is no special configuration other than a normal setup procedure.

20.2.2 Input Items

There are seventeen input default files needed to execute this program. Sixteen files are formatted files and items in the files are position dependent. The seventeenth file, the MSID file, is generated by a successful execution of ILD and the file is binary.

20.2.2.1 Sample Input

See Section 6.0 and Appendix A. The following are examples of specific Input files.

CGTABLE

CGTABLE is a file of the planned CG locations and their times of applicability. The following is a sample of the file on ascent:

```
            (default)
    0.0d0    ,-36.306d0,0.021d0  ,-1.569d0
    6.4d0    ,-36.348d0,0.022d0  ,-1.628d0
   60.8d0    ,-31.234d0,0.029d0  ,-2.342d0
           --- (etc.,) ---
2766.0d0     ,-71.757d0,-0.025d0 ,-26.217d0
2902.2d0     ,-71.182d0,-0.025d0 ,-26.042d0
-9999.0d0    ,-9999.0d0,-9999.0d0,-9999.0d0
             ,         ,         ,
           --- (etc., blanks as needed) ---
             ,         ,         ,
```

DEL_INTRVLS

DEL_INTRVLS is a file of radar data intervals to be deleted before using the filter (LRBET5). The following is a sample of a DEL_INTRVLS file:

```
            (default)
0.d0         ,0.d0
0.d0         ,0.d0
0.d0         ,0.d0
      --- ( etc., 39 pairs needed) ---
0.d0         ,0.d0
0.d0         ,0.d0
0.d0         ,0.d0
```

DEORBIT_VEC (Descent only)

DEORBIT_VEC is a file of deorbit state vectors (position & velocity) in Mean-of-50 coordinates (meters & meters/second). This file is needed only on descent. The following is a sample of a DEORBIT_VEC file:

```
            (default)
 5846678.8
 -697302.0
-3201586.8
   1075.8247
   7636.811
    318.1832
```

DEWPOINTS

DEWPOINTS is a file of the radar station dry bulb/wet bulb temperature and pressure measurements to correct the refraction from the mean monthly average refraction correction. The following is a sample of the DEWPOINTS file:

```
            (default)
1
'ANTC','CNVC','GBIC','GTKC','KPTC','MLAC','PATC','PAFC'
'CNMC','MLMC','CNOC','KMTC','    ','    ','    ','    '
'VDBC',60.0  ,56.0  ,1009.0
'VDFC',56.0  ,51.0  ,945.0
'EFFC',50.0  ,46.0  ,937.0
'FRCC',47.5  ,43.0  ,934.3
'SNFC',59.0  ,56.0  ,988.5
'    ',-9999.,-9999.,-9999.
'    ',      ,      ,
          --- (etc., as required) ---
```

IMUMATS

IMUMATS is a file of IMU matrix transformation values. Normally, these values are set to zero and not used. The following is a sample of the zero entry file.

```
             (default)
0.0d0                 ,0.0d0                  ,0.0d0
0.0d0                 ,0.0d0                  ,0.0d0
0.0d0                 ,0.0d0                  ,0.0d0
          --- (etc., 12 line entries) ---
0.0d0                 ,0.0d0                  ,0.0d0
0.0d0                 ,0.0d0                  ,0.0d0
0.0000000000000  --- (6 entries) ---
0.0000000000000
0.0000000000000
0.0000000000000
0.0000000000000
0.0000000000000
```

IMUSELECT

IMUSELECT is a file used to choose IMU criteria for the automatic selection of the quaternion values. The following is a sample of the IMUSELECT file:

```
             (default)
42890.0d0  ,7,0.050000
47285.0d0  ,7,0.050000
-9999.0d0  ,0,-9999.0d0
-9999.0d0  ,0,-9999.0d0
         --- (etc., to end of file) ---
```

MSID

MSID is a binary file. The file is generated by a succesful execution of ILD. The elements in the file are defined in Section 19.2.3.1.

RADAR

RADAR is a formatted file of all approved radar stations used in the processing of STS flights. The data consists of geodetic latitude, longitude, altitude and other station parameters. The following is a shortened sample of the file RADAR:

```
 1 antc 17  8 37.58 298 12 27.15   -33.10         42.00
 2 bdqc 32 20 53.04 295 20 47.92   -35.25         21.00
 3 bdas 32 21  5.00 295 20 31.94   -33.75 n/s     23.00
                --- (etc.,) ---
52 blxs 38 59 53.94 283  9 29.14     4.00 e/w     39.00
53 cans-35 24 18.29 148 58 57.91   655.30 e/w    655.00
54 vans 34 33 56.64 239 29 53.77   570.87 e/w    631.00
```

RADSELECT

RADSELECT is a file of manually selected radar stations and their time of usage for each radar slot in the filter (LRBET5). The following is a sample of the RADSELECT file:

```
             (default)
'KPTC',567390.1d0    ,567475.1d0    ,0
'VDFC',568024.1d0    ,568062.1d0    ,0
'VDBC',568062.11d0   ,568294.1d0    ,0
'FRCC',568294.11d0   ,568724.1d0    ,0
'    ',000000.0      ,000000.0      ,0
'    ',000000.0      ,000000.0      ,0
'    ',000000.0      ,000000.0      ,0
```

```
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'SNFC',568047.1d0    ,568099.1d0   ,0
'VDFC',568099.11d0   ,568218.1d0   ,0
'SNFC',568218.11d0   ,568315.1d0   ,0
'EFFC',568315.11d0   ,568722.1d0   ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'VDFC',568062.1d0    ,568070.1d0   ,0
'SNFC',568099.11d0   ,568218.1d0   ,0
'VDFC',568218.11d0   ,568294.1d0   ,0
'VDBC',568294.11d0   ,568371.1d0   ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'GWMS',566399.1d0    ,566769.1d0   ,1
'GDXS',568192.1d0    ,568707.1d0   ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
'    ',000000.0      ,000000.0     ,0
```

RCV

RCV is the file of the Rarely Changed Variables for the input data. The following is a sample of the RCV file:

```
                    (default)
0.0d0
-113.0d0
1.55d0
20285.0d0
40.0d0
0.0d0
1.0d0
1.0d0
1.0d0
1.0d0
1.0d0
1.0d0
1.0d0
-15.349000d0
0.0d0
-29.875000d0
'FALSE'
0.0100d0  ,0.0000d0  ,0.0000d0  ,0.0000d0  ,0.0000d0    ,0.0000d0
0.0000d0  ,0.0100d0  ,0.0000d0  ,0.0000d0  ,0.0000d0    ,0.0000d0
0.0000d0  ,0.0000d0  ,0.0100d0  ,0.0000d0  ,0.0000d0    ,0.0000d0
0.0000d0  ,0.0000d0  ,0.0000d0  ,0.0001d0  ,0.0000d0    ,0.0000d0
0.0000d0  ,0.0000d0  ,0.0000d0  ,0.0000d0  ,0.0001d0    ,0.0000d0
0.0000d0  ,0.0000d0  ,0.0000d0  ,0.0000d0  ,0.0000d0    ,0.0001d0
'FALSE'
0.0d0
0.0d0
10.0d0
6378166.0d0
-208.0d0
0.0d0
0.0d0
```

0.001082627d0
3.9860047d+14
19.128d0
0.0d0
-6.388d0
34.93225d0
0.0d0
35.16670d0
0.0d0
0.0d0
7.2921151464592d-5
0.0d0
298.30d0
6378139.0d0
240.0d0
221.0d0
17590.0d0
18588.0d0
21273.0d0
30.550d0
40.814d0
60.227d0
0.0d0
1500.0d0
3000.0d0
1000.0d0
2500.0d0

REFSMATS

REFSMATS is a file of the IMU reference matrix at lift off or as modified by realignment while on orbit. The following is a sample of the REFSMATS file:

(default)
0.613397538661956787d0 , 0.450351297855376900d0 , 0.648788988590240479d0

```
-0.377315282821655273d0 ,-0.554566204547882080d0 , 0.741680145263671875d0
 0.693813085556030273d0 ,-0.699742794036865234d0 ,-0.170245051383972168d0
 0.295444071292877197d0 ,-0.731741309165960000d0 , 0.614220976829528809d0
-0.588084608316421509d-1, 0.627772152424000000d0 , 0.776172459125518799d0
-0.953548252582550049d0 ,-0.265436947345730000d0 , 0.142438948154449463d0
-0.554404318332672119d0 , 0.125068664550781250d0 , 0.822796225547800000d0
 0.790629863739013672d0 ,-0.229574143886566162d0 , 0.567626774311065674d0
 0.259885072708129883d0 , 0.965222001075745000d0 , 0.283938609063625336d-1
```

RUNWAY

RUNWAY is a file of all the statistics on STS Shuttle approved runways. This includes the latitude, longitude, mean sea level altitude, runway azimuth, and all MSBLS antenna statistics, if avaiable. The following is a shortened sample of the RUNWAY file:

```
am102
amilcar cabral
16.72472222d0
-22.95166667d0
.0000000000d0
177.00d0
.00d0
0.00000000d0
0.00000000d0
0.00000000d0
0.00000000d0
0.00000000d0
0.00000000d0
0.00000000d0
0.00000000d0
0.00000000d0
0.00000000d0
0.00000000d0
0.00000000d0
```

0.00000000d0
0.00000000d0
0.00000000d0
--- (etc., for 56 other landing sites) ---

RUNWAYDATA (Descent only)

RUNWAYDATA is a file of the touchdown data used for descent only. It includes the code for the landing runway and the touchdown and landing runway stopping points. The following is a sample of the RUNWAYDATA file:

```
            (default)
'edw22'
572.0
0.0
11727.0
-11.347
11.347
```

SBAND

SBAND is a file containing the beacon delay correction and the s-band frequencies of the s-band stations. The following is a sample of the SBAND file:

```
            (default)
2106384288.0
2106406288.0
2106406288.0
2106406288.0
2106406288.0
2106423296.0
2106422288.0
2106406300.0
```

2106406300.0
2106406300.0
2106406300.0
2106406300.0
2106406300.0
2106406300.0
2106406300.0
137.0

SET

SET is a file of the Special Event Times and the related title for that event. The following is a sample of an ascent SET file:

```
           (default)
  0,11,54,53.725d0,'mps start (me-3 start)                    '
  0,11,55,0.000d0 ,'srb ignition (get = 0 )                   '
  0,11,55,0.000d0 ,'lift-off                                  '
  0,11,55,56.000d0,'max q                                     '
  0,11,57, 4.100d0,'end srm action                            '
  0,11,57, 7.000d0,'srb sep cmd                               '
  0,12, 2,28.000d0,'3g acceleration                           '
  0,12, 3,22.000d0,'meco                                      '
  0,12, 3,40.000d0,'et sep                                    '
  0,12, 5,22.000d0,'oms - 1st burn ignition                   '
  0,12, 8, 6.000d0,'oms - 1st burn cutoff                     '
  0,12, 9, 4.000d0,'apu deactivation                          '
  0,12,41, 6.000d0,'oms - 2nd burn ignition                   '
  0,12,43,21.000d0,'oms - 2nd burn cutoff                     '
-99,99,99,99.d0   ,'                                          '
   ,  ,  ,        ,'                                          '
       --- (etc.,) ---
```

START-STOP

START-STOP is a file of the specific flight variables that change flight-by-flight. The following is a sample of the START-STOP file:

```
            (default)
42890.0d0
45820.0d0
'61C'
12
'12','JAN',1986
42900.000d0
112784.0d0
75.0
55.53d0
'fo'
'n'
'y'
'y'
'y'
'y'
'n'
'n'
'n'
'n'
```

UPDATE_VEC (Ascent only)

UPDATE_VEC is a file of the update vector(position & velocity). The following is a sample of the UPDATE_VEC file:

```
            (default)
-14406983.35d0
-61946237.07d00
-33448489.67d00
```

81513.64544d0
-14369.48009d0
-8481.050171d0

20.2.2.2 Definition of Inputs

MSID

MSID is generated as a result of a succesful reading of a valid I-load tape. Data on the tape are necessary for proper generation of the ascent input files and unless manual overrides are used, necessary for Descent also. The following variables are in MSID in the following order:

(1) nav base to nav body transformation (double precision) - The nine elements of the nav base to nav body transformation matrix.

(2) nav base to IMU1 case transformation (double precision) - The nine elements of the nav base to IMU1 case transformation matrix.

(3) nav base to IMU2 case transformation (double precision) - The nine elements of the nav base to IMU2 case transformation matrix.

(4) nav base to IMU3 case transformation (double precision) - The nine elements of the nav base to IMU3 case transformation matrix.

(5) launch latitude (double precision) - The launch latitude of the pad in degrees(+ north latitude).

(6) launch longitude (double precision) - The launch longitude of the pad in degrees(+ east longitude).

(7) vector normal to the flight plane (double precision) - The three element vector that describes the normal to the flight path(used to calculate inclination of the orbit and launch azimuth).

(8) xsubo (double precision) - the height of the nav base relative to the Fisher ellipsoid in feet at the launch point.

(9) rgao (double precision) - The azimuth misalignment of nav base with respect to the outer roll.

(10) rgpo (double precision) - The pitch misalignment of nav base with respect to the outer roll.

20.2.3.2 Sample Output

There are 17 binary files written out and one formatted file, WRITE66.

WRITE66

The WRITE66 file is a special debug file since it contains a formatted copy of the data written to the 17 binary files. It is formatted such that each binary file data is separated under the heading of that file. The following is a compressed sample of the WRITE66 file:

```
 input version of july  1, 1986
tnbbod and error

 .98295650  .00043633 -.18383790   .447545E-07 -.398915E-10  .387099E-07
-.00045295  .99999990 -.00004840  -.398915E-10  .750746E-08 -.545919E-10
 .18383790  .00013084  .98295660   .387099E-07 -.545919E-10  .680815E-07

tnbrll and error

 .99999841  .00163576  .00070200  -.111022E-15  .205458E-18  .000000E+00
-.00163576  .99999866 -.00000114   .205458E-18  .000000E+00  .211758E-21
-.00070201  .00000000  .99999975   .000000E+00  .211758E-21 -.111022E-15
```

tnbrl2 and error

.99999161	.00230952	.00338036	-.948473E-08	.826379E-10	.312176E-10
-.00230956	.99999732	.00000778	.826379E-10	-.946780E-08	-.285802E-12
-.00338033	-.00001559	.99999428	.312176E-10	-.285802E-12	.235338E-09

tnbrl3 and error

.99999624	.00273883	-.00001790	-.618790E-08	.543988E-10	-.117898E-11
-.00273883	.99999624	.00001795	.543988E-10	-.587262E-08	-.217303E-12
.00001795	-.00001790	.99999999	-.117898E-11	-.217303E-12	.328736E-09

trlbd1 and error

.98282660	-.00117133	-.18452790	.447545E-07	-.398915E-10	.387099E-07
.00118277	.99999930	-.00004808	-.398915E-10	.750746E-08	-.545919E-10
.18452786	-.00017099	.98282730	.387099E-07	-.545919E-10	.680815E-07

trlbd2 and error

.98232782	-.00183530	-.18715957	.355985E-07	.414088E-10	.369519E-07
.00185641	.99999827	-.00006247	.414088E-10	-.196003E-08	-.399510E-10
.18715940	-.00028608	.98232954	.369519E-07	-.399510E-10	.679878E-07

trlbd3 and error

.98295729	-.00225912	-.18382025	.387870E-07	.129875E-10	.375313E-07
.00228588	.99999738	-.00006631	.129875E-10	.163508E-08	-.453453E-10
.18381996	-.00035500	.98295989	.375313E-07	-.453453E-10	.681896E-07

JULIAN DATE = 2446442.5

RNP MATRIX

-.3540152012516661D+00	.9352388795881591D+00	.1214656094066681D-02
-.9352331767471923D+00	-.3540172844595411D+00	.3266100924153619D-02

.3484593820901000D-02 .2026269846312058D-04 .9999939285792321D+00

Lear station = 1 bign = .000000 hs6 = 17590.000
Lear station = 2 bign = .000341 hs6 = 7141.150
Lear station = 3 bign = .000341 hs6 = 7138.165
Lear station = 4 bign = .000302 hs6 = 7008.034
Lear station = 5 bign = .000323 hs6 = 7270.424
Lear station = 6 td = 60.0 tw = 56.0 p = 1009.0 bign = .000333 hs6 =
6710.606
Lear station = 7 td = 56.0 tw = 51.0 p = 945.0 bign = .000306 hs6 =
6788.046
Lear station = 8 bign = .000000 hs6 = 17590.000
Lear station = 9 bign = .000290 hs6 = 7725.389
Lear station = 10 td = 50.0 tw = 46.0 p = 937.0 bign = .000300 hs6 =
7332.018
Lear station = 11 td = 47.5 tw = 43.0 p = 934.3 bign = .000294 hs6 =
7571.532
Lear station = 12 bign = .000000 hs6 = 17590.000
Lear station = 13 bign = .000283 hs6 = 7803.296
Lear station = 14 bign = .000283 hs6 = 7794.357
Lear station = 15 bign = .000000 hs6 = 17590.000
Lear station = 16 bign = .000336 hs6 = 7193.001
Lear station = 17 bign = .000310 hs6 = 6588.083
Lear station = 18 bign = .000000 hs6 = 17590.000
Lear station = 19 bign = .000335 hs6 = 7344.047
Lear station = 20 bign = .000335 hs6 = 7342.583
Lear station = 21 bign = .000000 hs6 = 17590.000
Lear station = 22 bign = .000000 hs6 = 17590.000
Lear station = 23 bign = .000000 hs6 = 17590.000
Lear station = 24 bign = .000314 hs6 = 7221.107
Lear station = 25 td = 59.0 tw = 56.0 p = 988.5 bign = .000330 hs6 =
6485.997
Lear station = 26 bign = .000314 hs6 = 7221.107
Lear station = 27 bign = .000316 hs6 = 7921.561
Lear station = 28 bign = .000316 hs6 = 7917.889
Lear station = 29 bign = .000316 hs6 = 7909.298

```
Lear station = 30   bign =   .000233   hs6 =    7607.874
Lear station = 31   bign =   .000263   hs6 =    7381.260
Lear station = 32   bign =   .000272   hs6 =    7856.273
Lear station = 33   bign =   .000268   hs6 =    7965.245
Lear station = 34   bign =   .000259   hs6 =    7973.299
Lear station = 35   bign =   .000272   hs6 =    7475.485
Lear station = 36   bign =   .000268   hs6 =    7956.240
Lear station = 37   bign =   .000259   hs6 =    7845.586
Lear station = 38   bign =   .000000   hs6 =   17590.000
Lear station = 39   bign =   .000000   hs6 =   17590.000
Lear station = 40   bign =   .000323   hs6 =    7252.212
Lear station = 41   bign =   .000298   hs6 =    7483.049
Lear station = 42   bign =   .000307   hs6 =    6842.936
Lear station = 43   bign =   .000000   hs6 =   17590.000
Lear station = 44   bign =   .000298   hs6 =    7478.324
Lear station = 45   bign =   .000000   hs6 =   17590.000
Lear station = 46   bign =   .000373   hs6 =    6133.451
Lear station = 47   bign =   .000370   hs6 =    6062.473
Lear station = 48   bign =   .000383   hs6 =    5786.079
Lear station = 49   bign =   .000383   hs6 =    5827.048
Lear station = 50   bign =   .000354   hs6 =    5706.291
Lear station = 51   bign =   .000313   hs6 =    6978.406
Lear station = 52   bign =   .000312   hs6 =    8011.850
Lear station = 53   bign =   .000307   hs6 =    7334.432
Lear station = 54   bign =   .000302   hs6 =    7560.053


 runm50 version of mar. 17, 1982
   1  521970.000  564870.000   18 12 54 30.000   DEORBIT BURN
IGNITION
   2  522202.000  565102.000   18 12 58 22.000   DEORBIT BURN
CUTOFF
   3  523983.000  566883.000   18 13 28  3.000   ENTRY INTERFACE (400000 FT )
   4  525032.000  567932.000   18 13 45 32.000   BLACKOUT
END
   5  525466.000  568366.000   18 13 52 46.000
```

```
TAEM
   6  525831.000  568731.000    18 13 58 51.000    MLG
CONTACT
   7  525847.000  568747.000    18 13 59  7.000    NLG CONTACT
   8  525890.000  568790.000    18 13 59 50.000    WHEEL STOP

 MSBLS DATA     Range Station    Azimuth Station     Elevation Station

                     34.891524      34.891524           34.910250
                   -117.907720    -117.907720         -117.871023
                   2304.960000    2304.960000         2289.830000
                   2120.540000    2120.540000         2105.410000
                    238.216126     238.216126          238.237123

 *****************  landqa.in  *****************

 --- Ascent flag is F

 Geodetic latitude is      34.916280   Geodetic longitude is    -117.862418
Geodetic height is    2096.58     Runway height above mean sea level is
2281.00
Runway azimuth is    238.241   Touchdown point from approach is:  X  572.0   Y
.0

 --- Earth constants ---

 Equitorial radius is     20925741.47   Polar radius is     20855591.48
 Earth rotation rate is     .000072921151

 --- Mean of 50 to ECI Transformation ---

    -.3540152013     -.9352331767     .0034845938
     .9352388796     -.3540172845     .0000202627
     .0012146561      .0032661009     .9999939286
```

```
*****************  msbls.in  ******************

Start time =    564860.000  Stop time =    568800.000
          Clock bias of onboard clock is      .000000
          Drift rate onboard clock is     .00000000 referenced to    .000000

****************  mslrresid.in ****************

--- p array as in LRBET5.IN  ---

 --- ps array as in LRBET5.IN  ---

--- initial state array as in LRBET5.IN ---

****************  msobresid.in ****************

--- p array as in LRBET5.IN  ---

 --- ps array as in LRBET5.IN  ---

--- initial state array as in LRBET5.IN ---

 --- number of days is    12

*****************  gtrack.in *****************

 Search from =         .000 Search till =        .100E+11
     Year of launch =  1986 Epoch of rnp =   12.

---  rnp and error  ---

-.3540152E+00  .9352388E+00  .1214656E-02 -.333066E-15 -.191594E-15 -.522585E-
16
-.9352331E+00 -.3540172E+00  .3266100E-02 -.191594E-15 -.555111E-15  .221177E-
16
 .3484593E-02  .2026269E-04  .9999939E+00 -.522585E-16  .221177E-16
```

.000000E+00

***************** i2iipc.in ****************

----- SRB ignition time is : 42900.000

--- center of gravity table begins: ---

time	X comp	Y comp	Z comp
564870.000	-56.084	.033	3.892
565044.400	-55.209	.033	4.217
567067.800	-55.509	.033	4.217
568519.400	-55.359	.033	4.275
568806.800	-55.484	.033	4.483
568897.200	-55.484	.033	4.483
-9999.000	-9999.000	-9999.000	-9999.000

--- special event times and descriptions ---

time	event description
521970.000	DEORBIT BURN IGNITION
522202.000	DEORBIT BURN CUTOFF
523983.000	ENTRY INTERFACE (400000 FT)
525032.000	BLACKOUT END
525466.000	TAEM
525831.000	MLG CONTACT
525847.000	NLG CONTACT
525890.000	WHEEL STOP
-9999.000	

--- tracker array ---

1.	17.143772	298.207541	137.7952	-108.5958	.0000
2.	32.348066	295.346644	68.8976	-115.6496	.0000

3.	32.351388	295.342205	75.4593	-110.7283	.0000
4.	34.582761	239.438525	2171.9160	1972.1456	.0000
5.	37.497841	237.500391	173.8845	-27.0341	.0000
6.	34.665866	239.418650	403.5433	203.5433	.0000
7.	34.583052	239.438980	2171.9160	1972.1784	.0000
8.	28.481763	279.423527	45.9317	-163.9107	.0000
9.	34.969616	242.069738	2723.0971	2521.7191	.0000
10.	34.970458	242.068583	2742.7821	2540.2230	.0000
11.	34.960827	242.088561	2680.4461	2480.3477	.0000
12.	26.615758	281.652230	39.3700	-168.0118	.0000
13.	35.342205	243.126544	3172.5721	2994.4553	.0000
14.	35.341566	243.126400	3192.2572	3014.1404	.0000
15.	21.462738	288.867994	118.1102	-142.1587	.0000
16.	13.310630	144.736811	301.8372	380.4133	.0000
17.	22.126238	200.334844	3776.2467	3739.3372	.0000
18.	21.572097	201.733427	967.8477	931.3976	.0000
19.	28.508308	279.307272	26.2467	-183.1364	.0000
20.	28.508269	279.306625	29.5275	-178.6417	.0000
21.	28.424858	279.335638	36.0892	-172.0144	.0000
22.	28.226550	279.400750	49.2125	-160.3674	.0000
23.	28.227475	279.393927	45.9317	-162.3687	.0000
24.	33.247000	240.479997	931.7585	730.4133	.0000
25.	33.247708	240.479350	931.7585	732.1522	.0000
26.	33.248416	240.478700	931.7585	730.2493	.0000
27.	37.841333	284.514950	39.3700	-152.2965	.0000
28.	37.860252	284.490741	49.2125	-143.8320	.0000
29.	37.944091	284.535816	72.1784	-119.5538	.0000
30.	32.441719	249.211200	9179.7900	9036.4829	.0000
31.	31.556827	249.561827	5964.5669	5822.0800	.0000
32.	32.358100	253.630191	4048.5564	3905.9711	.0000
33.	32.901513	253.900827	4156.8241	4012.9593	.0000
34.	33.813911	253.340997	5029.5275	4886.9422	.0000
35.	31.571055	249.629202	4944.2257	4802.8543	.0000
36.	33.096172	253.840855	4179.7900	4038.6482	.0000
37.	33.445227	253.867902	5334.6456	5191.0761	.0000
38.	28.528883	279.409819	19.6850	-195.1771	.0000

39.	28.626088	279.317233	32.8083	-173.9829	.0000
40.	37.497697	237.501358	206.6929	6.7257	.0000
41.	40.456208	355.830427	2565.6167	2644.6522	.0000
42.	-35.628913	148.956744	3057.7427	3056.4304	.0000
43.	28.492988	279.424547	45.9317	-164.0419	.0000
44.	40.455461	355.831555	2575.4593	2654.1666	.0000
45.	8.719500	167.718369	91.5682	91.5682	.0000
46.	-7.906588	345.597533	108.2677	77.5918	.0000
47.	-7.972530	345.598816	390.4199	359.3175	.0000
48.	9.395383	167.479130	167.3228	104.0026	.0000
49.	9.398552	167.482691	101.7060	37.3359	.0000
50.	-7.954825	345.672936	1765.0918	1733.4973	.0000
51.	-33.151000	289.333630	2385.1706	2318.2742	.0000
52.	38.998316	283.158094	127.9527	13.1233	.0000
53.	-35.405080	148.982752	2148.9501	2149.9343	.0000
54.	34.565733	239.498269	2070.2099	1872.9330	.0000
202.	34.891523	-117.907720	2304.9600	2120.5400	238.2161
203.	34.910250	-117.871022	2289.8300	2105.4100	238.2371
.100E+05	-9999.0	-9999.0000	9999.0000	-9999.0000	-9999.0000

--- individual values ---

delta= 28.52762 grr(1)= .000 kappa = 90.00000 lamo = 279.39591
phio = 28.6084 rsubo 20925739.07 xsubo = -2.400
x navo = 34.93 y navo = .00 z navo = 35.17

--- refsmatts and error ---

ref 1 and error

.613397	.450351	.648788	-.16367E-07	.35555E-07	.48812E-07
-.377315	-.554566	.741680	.35555E-07	-.64244E-07	.50405E-07
.693813	-.699742	-.170245	.48812E-07	.50405E-07	-.46983E-07

ref 2 and error

```
 .295444 -.731741  .614220      -.48820E-07 -.21734E-07 -.86914E-08
-.058808  .627772  .776172      -.21734E-07 -.32705E-08 -.30040E-07
-.953548 -.265436  .142438      -.86914E-08 -.30040E-07 -.10302E-06

 ref 3 and error

-.554404  .125068  .822796      -.52185E-07  .25172E-07 -.18327E-07
 .790629 -.229574  .567626       .25172E-07  .23892E-07  .74210E-09
 .259885  .965222  .028393      -.18327E-07  .74210E-09 -.26285E-07

*****************  lrbet5.in  *****************

--- p array is as follows: ---

 1              57.2957795          10.0000000
.0001000000                  1.0000000000
 5            1800.0000000          30.0000000
2.0000000000          299792458.0000000000
 9                .0000729     6378139.0000000                .0010826270
398600470000000.0000000000
13 4902780000000.00000000*******************
398615280000000.0000000000               6378166.0000000000
17                .0033523     6378000.0000000
.0003200000                8000.0000000000
21                .2000000        1000.0000000
1.5000000000                  600.0000000000
25               2.0000000         400.0000000
5.0000000000                    6.0000000000
29               6.0000000           7.0000000
4.0000000000                     .0000064120
33                .0000060        9000.0000000
47250.0000000000                     .0001600000
37                .0008400            .0000002
12.0000000000                     .0001000000
41                .0001500          12.0000000
12.0000000000                   28.0000000000
```

45 8.0000000 .0003500
.0003500000 400.0000000000
49 400.0000000 10.0000000
.0001500000 .0002000000
53 10.0000000 10.0000000
2.0000000000 .0080000000
57 60.0000000 8.0000000
.0005000000 .0005000000
61 137.0000000 .0010000
.0010000000 .0010000000
65 1.0859728 1000.0000000
240000000.0000000000 240000000.0000000000
69 1000.0000000 .0000000
249.9000000000 96426.0000000000
73 75.0000000 .0204600
.8421000000 .9090000000
77 2.1690000 .0000000
.5000000000 .3333333333
81 .6666666 1.0000000
.1250000000 .0555555556
85 .0000000 .1111111
.0000000000 .1111111111
89 .0000000 -.7272727
.8181818182 .4090909091
93 .0916666 -.2666666
.4500000000 .2250000000
97 .0000000 .0916666
-.5333333333 .6750000000
101 .6750000 .0916666
.0000000000 10000.0000000000
105 5000000.0000000 6.2831853
1.8000000000 140000.0000000000
109 4.0000000 .0000000
77422.0000000000 871960.0000000000
113 127130.0000000 146232.0000000
159076.0000000000 .0000000000

117	.0000000	.0000000
564860.0000000000	568800.0000000000	
121	.0000000	1.0000000
.0000000000	1.0000000000	
125	1.0000000	1.0000000
1.0000000000	1.0000000000	
129	.0000000	1.0000000
1.0000000000	1.0000000000	
133	.0000000	.0000000
.0000000000	.0000000000	
137	.0000000	-.3540152
.9352388796	.0012146561	
141	-.9352331	-.3540172
.0032661009	.0034845938	
145	.0000202	.9999939
.0002660000	7754.0000000000	
149	.5672411	4.4225148
1441.3700000000	.5672411118	
153	4.4225148	1441.3700000
2287500000.0000000000	-2127500000.0000000000	
157	.0000001	.5672411
4.4225148180	1441.3700000000	
161	.5672411	4.4225148
1441.3700000000	2287500000.0000000000	
165	2127500000.0000000	.0000001
568800.0000000000	-4553524.6532606706	
169	-2565082.6026315	3645034.0389487
187.0530271607	-332.9724502472	
173	-.6450608	.0100000
.0001000000	.0000000000	
177	.0000000	.0000000
.0000000000	.0000000000	
181	.0000000	.0000000
.0000000000	.0000000000	
185	.0000000	.0000000
.0000000000	.0000000000	

189	.0000000	.0000000
.0000000000	.0000000000	
193	.0000000	.0000000
.0000000000	.0000000000	
197	.0000000	.0000000
.0000000000	.0000000000	
201	.0000000	.0000000
.0000000000	.0000000000	
205	.0000000	.0000000
.0000000000	.0000000000	
209	.0000000	.0000000
.0000000000	.0000000000	
213	.0000000	.0000000
.0000000000	.0000000000	
217	.0000000	.0000000
.0000000000	.0000000000	
221	.0000000	.0000000
.0000000000	.0000000000	
225	.0000000	.0000000
.0000000000	.0000000000	
229	.0000000	.0000000
.0000000000	.0000000000	
233	.0000000	.0000000
.0000000000	.0000000000	
237	.0000000	.0000000
.0000000000	.0000000000	
241	.0000000	.0000000
.0000000000	.0000000000	
245	.0000000	.0000000
.0000000000	.0000000000	
249	.0000000	.0000000
.0000000000	.0000000000	
253	.0000000	.0000000
.0000000000	.0000000000	
257	.0000000	.0000000
.0000000000	.0000000000	

261	.0000000		
.0000000**************************			.3333333333
265	.3333333	.3333333	
.0000000000	.0000000000		
269	.0000000	.0000000	
.0000000000	.0000000000		
273	.0000000	.0000000	
.0000000000	.0000000000		
277	.0000000	.0000000	
.0000000000	.0000000000		
281	.0000000	.0000000	
.0000000000	.0000000000		
285	.0000000	.0000000	
.0000000000	.0000000000		
289	.0000000	.0000000	
.0000000000	.0000000000		
293	.0000000	.0000000	
.0000000000	.0000000000		
297	.0000000	.0000000	
.0000000000	.0000000000		
301	.0000000	.0000000	
.0000000000	.0000000000		
305	.0000000	.0000000	
.0000000000	.0000000000		
309	.0000000	.0000000	
.0000000000	.0000000000		
313	.0000000	.0000000	
.0000000000	.0000000000		
317	.0000000	.0000000	
.0000000000	.0000000000		
321	.0000000	.0000000	
.0000000000	.0000000000		
325	.0000000	.0000000	
.0000000000	.0000000000		
329	.0000000	.0000000	
.0000000000	.0000000000		

333	.0000000	.0000000
.0000000000	.0000000000	
337	.0000000	.0000000
.0000000000	.0000000000	
341	.0000000	.0000000
.0000000000	.0000000000	
345	.0000000	.0000000
.0000000000	.0000000000	
349	.0000000	.0000000
.0000000000	.0000000000	
353	.0000000	.0000000
.0000000000	.0000000000	
357	.0000000	.0000000
.0000000000	.0000000000	
361	.0000000	.0000000
.0000000000	.0000000000	
365	.0000000	.0000000
.0000000000	.0000000000	
369	.0000000	.0000000
.0000000000	.0000000000	
373	.0000000	.0000000
.0000000000	.0000000000	
377	.0000000	.0000000
.0000000000	.0000000000	
381	.0000000	.0000000
.0000000000	.0000000000	
385	.0000000	.0000000
.0000000000	.0000000000	
389	.0000000	.0000000
.0000000000	.0000000000	
393	.0000000	.0000000
.0000000000	.0000000000	
397	.0000000	.0000000
.0000000000	.0000000000	
401	.0000000	.0000000
.0000000000	.0000000000	

405	.0000000	.0000000
.0000000000		.0000000000
409	.0000000	.0000000
.0000000000		.0000000000
413	.0000000	.0000000
.0000000000		.0000000000
417	.0000000	.0000000
.0000000000		.0000000000
421	.0000000	.0000000
.0000000000		.0000000000
425	.0000000	.0000000
.0000000000		.0000000000
429	.0000000	.0000000
.0000000000		.0000000000
433	.0000000	.0000000
.0000000000		.0000000000
437	.0000000	.0000000
.0000000000		.0000000000
441	.0000000	.0000000
.0000000000		.0000000000
445	.0000000	.0000000
.0000000000		.0000000000
449	.0000000	.0000000
.0000000000		.0000000000
453	.0000000	.0000000
.0000000000		.0000000000
457	.0000000	.0000000
.0000000000		.0000000000
461	.0000000	.0000000
.0000000000		.0000000000
465	.0000000	.0000000
.0000000000		.0000000000
469	.0000000	.0000000
.0000000000		.0000000000
473	.0000000	.0000000
.0000000000		.0000000000

477	.0000000	.0000000
.0000000000	.0000000000	
481	.0000000	.0000000
.0000000000	.0000000000	
485	.0000000	.0000000
.0000000000	.0000000000	
489	.0000000	.0000000
.0000000000	.0000000000	
493	.0000000	.0000000
.0000000000	.0000000000	
497	.0000000	.0000000
.0000000000	.0000000000	
501	.0000000	.0000000
.0000000000	.0000000000	
505	.0000000	.0000000
.0000000000	.0000000000	
509	.0000000	.0000000
.0000000000	.0000000000	
513	.0000000	.0000000
.0000000000	.0000000000	
517	.0000000	.0000000
.0000000000	.0000000000	
521	.0000000	.0000000
.0000000000	.0000000000	
525	.0000000	.0000000
.0000000000	.0000000000	
529	.0000000	.0000000
.0000000000	.0000000000	
533	.0000000	.0000000
.0000000000	.0000000000	
537	.0000000	.0000000
.0000000000	.0000000000	

big parray #'s: p(14)= .1327124990E+21 p(263) 0.1000000000E+33

--- ps array is as follows: ---

1	.299215	5.204703	-33.10	.000000	17590.00000	.00
7	.564580	5.154771	-35.25	.000341	7141.15042	.00
13	.564638	5.154693	-33.75	.000341	7138.16461	2106384288.00
19	.603583	4.178990	601.11	.000302	7008.03383	.00
25	.654460	4.145163	-8.24	.000323	7270.42430	.00
31	.605033	4.178643	62.04	.000333	6710.60633	.00
37	.603588	4.178998	601.12	.000306	6788.04621	.00
43	.497100	4.876860	-49.96	.000000	17590.00000	.00
49	.610334	4.224914	768.62	.000290	7725.38941	.00
55	.610349	4.224893	774.26	.000299	7332.01762	.00
61	.610181	4.225242	756.01	.000294	7571.53200	.00
67	.464532	4.915758	-51.21	.000000	17590.00000	.00
73	.616837	4.243358	912.71	.000283	7803.29567	2106406288.00
79	.616826	4.243356	918.71	.000283	7794.35663	-2106406288.00
85	.374595	5.041697	-43.33	.000000	17590.00000	.00
91	.232314	2.526133	115.95	.000336	7193.00125	2106406288.00
97	.386175	3.496502	1139.75	.000310	6588.08298	2106406288.00
103	.376504	3.520912	283.89	.000000	17590.00000	.00
109	.497563	4.874831	-55.82	.000335	7344.04702	-2106423296.00
115	.497563	4.874820	-54.45	.000335	7342.58321	2106422288.00
121	.496107	4.875326	-52.43	.000000	17590.00000	.00
127	.492646	4.876463	-48.88	.000000	17590.00000	.00
133	.492662	4.876343	-49.49	.000000	17590.00000	.00
139	.580269	4.197167	222.63	.000314	7221.10689	.00
145	.580282	4.197156	223.16	.000330	6485.99741	.00
151	.580294	4.197145	222.58	.000314	7221.10689	.00
157	.660455	4.965722	-46.42	.000316	7921.56127	.00
163	.660786	4.965300	-43.84	.000316	7917.88852	.00
169	.662249	4.966086	-36.44	.000316	7909.29835	.00
175	.566214	4.349556	2754.32	.000233	7607.87417	.00
181	.550770	4.355675	1774.57	.000263	7381.25954	.00
187	.564755	4.426681	1190.54	.000272	7856.27343	.00
193	.574239	4.431405	1223.15	.000268	7965.24451	.00
199	.590164	4.421634	1489.54	.000259	7973.29914	.00
205	.551018	4.356851	1463.91	.000272	7475.48503	.00
211	.577637	4.430358	1230.98	.000268	7956.24027	.00

217	.583729	4.430830	1582.24	.000259	7845.58616	.00
223	.497922	4.876621	-59.49	.000000	17590.00000	.00
229	.499619	4.875005	-53.03	.000000	17590.00000	.00
235	.654458	4.145180	2.05	.000323	7252.21224	.00
241	.706094	6.210412	806.09	.000298	7483.04854	2106406300.00
247	-.621841	2.599785	931.60	.000307	6842.93574	2106406300.00
253	.497296	4.876878	-50.00	.000000	17590.00000	.00
259	.706081	6.210432	808.99	.000298	7478.32377	-2106406300.00
265	.152184	2.927237	27.91	.000000	17590.00000	.00
271	-.137996	6.031814	23.65	.000373	6133.45089	.00
277	-.139146	6.031837	109.52	.000370	6062.47257	.00
283	.163980	2.923062	31.70	.000383	5786.07910	.00
289	.164035	2.923124	11.38	.000383	5827.04762	.00
295	-.138837	6.033130	528.37	.000354	5706.29053	2106406300.00
301	-.578594	5.049824	706.61	.000313	6978.40586	2106406300.00
307	.680649	4.942041	4.00	.000312	8011.85002	-2106406300.00
313	-.617935	2.600239	655.30	.000307	7334.43171	-2106406300.00
319	.603285	4.180033	570.87	.000302	7560.05295	-2106406300.00
325	.000000	.000000	.00	.000000	.00000	.00
331	.000000	.000000	.00	.000000	.00000	.00
337	.000000	.000000	.00	.000000	.00000	.00
343	.000000	.000000	.00	.000000	.00000	.00
349	.000000	.000000	.00	.000000	.00000	.00
355	.000000	.000000	.00	.000000	.00000	.00
361	.608972	-2.057877	646.34	.609298	-2.05723	641.72
367	.000000	17590.000000	4.16	4.158022	.00000	.00

--- initial state array is ---

```
 5846678.800    -697302.000   -3201586.800  1075.8247   7636.8110
318.1832
        .000           .000           .000    .0000       .0000
.0000
        .000           .000           .000    .0000       .0000
.0000
        .000           .000
```

--- initial covariance matrix follows: ---

132.000000	.000000	.000000	.000000	.000000	.000000
.000000	1000.000000	.000000	.000000	.000000	.000000
.000000	.000000	66.000000	.000000	.000000	.000000
.000000	-.990000	.000000	1.150000	.000000	.000000
-.940000	.000000	.000000	.000000	.120000	.000000
.000000	.000000	.000000	.000000	.000000	.080000

***************** lrresid.in ****************

--- p array as in LRBET5.IN ---

--- ps array as in LRBET5.IN ---

--- initial state array as in LRBET5.IN ---

--- initial covariance matrix as in LRBET5.IN ---

--- number of days is 12

****************** merge.in *****************

--- Start time = 564860.000 Stop time = 568800.000

--- center of gravity table begins: ---

time	X comp	Y comp	Z comp
564870.000	-56.084	.033	3.892
565044.400	-55.209	.033	4.217
567067.800	-55.509	.033	4.217
568519.400	-55.359	.033	4.275
568806.800	-55.484	.033	4.483
568897.200	-55.484	.033	4.483

```
 -9999.000   -9999.000     -9999.000     -9999.000

 --- special event times ---

    time

564870.000
565102.000
566883.000
567932.000
568366.000
568731.000
568747.000
568790.000
 -9999.000

 *****************  opip.in  *****************

 --- Ascent variables ---

 Mission flag is set for ASCENT  F
 Astronomic latitude is       .0000000      Geodetic latitude is     28.6084216
 Astronomic longitude is      .0000000      Geodetic longitude is  279.3959095
 Astronomic mean sea level is      .00      Geodetic pad height is       .00
 Launch azimuth is   90.00000

 --- Descent variables ---

 Astronomic latitude is    34.9162800       Geodetic latitude is     34.9162800
 Astronomic longitude is -117.8624184       Geodetic longitude is -117.8624184
 Astronomic mean sea level is  2281.00      Geodetic runway height is  2096.58
 Runway azimuth is  238.24116

 --- Mean of 50 to ECI transformation ---

  -.35401520125      .93523887959      .00121465609
```

```
 -.93523317675      -.35401728446       .00326610092
  .00348459382       .00002026270       .99999392858

 --- Miscellaneous variables ---

 Cg variance  X=   1.00000    Y=   1.00000    Z=   1.00000
 Debug print requested = F

 --- Earth constants ---

 Equitorial radius in ft        20925741.47
 Polar radius in ft             20855591.48
 Rotation rate of earth in rads/sec     .0000729211514646

 --- Timing variables ---

 Onboard clock epoch year  1986  Year of epoch  1986  SRB ignition year  1986
 Onboard clock epoch day     12  Day of epoch     12  SRB ignition day     12
 Onboard clock epoch seconds     .000      SRB ignition seconds
42900.000
 Difference between onboard clock and ground     .000000
 Drift rate of onboard clock     .00000000

 -----    header data for output tape  -----

FLT 61C
1986    12
DESCENT BET OUTPUT PRODUCTS
START TIME    564860.0000
STOP  TIME    568800.0000
DATA RATE 1 PER SECOND
COMMENTS
LAUNCHED 09 JAN 1986

 *****************  raecomp.in ****************
```

--- p array as in LRBET5.IN ---

--- ps array as in LRBET5.IN ---

--- initial state array as in LRBET5.IN ---

--- initial covariance matrix as in LRBET5.IN ---

--- number of days is 12

***************** radar5.in *****************

Start time = 564860.000 Stop time = 568800.000

--- Manually selected radar station data ---

C-band 1 TRW id	Start	Stop
29.	567390.100	567475.100
23.	568024.100	568062.100
22.	568062.110	568294.100
37.	568294.110	568724.100
0.	.000	.000
0.	.000	.000
0.	.000	.000
0.	.000	.000
0.	.000	.000
0.	.000	.000

C-band 2 TRW id	Start	Stop
40.	568047.100	568099.100
23.	568099.110	568218.100
40.	568218.110	568315.100
39.	568315.110	568722.100
0.	.000	.000

0.	.000	.000
0.	.000	.000
0.	.000	.000
0.	.000	.000
0.	.000	.000

C-band 3

TRW id	Start	Stop
23.	568062.100	568070.100
40.	568099.110	568218.100
23.	568218.110	568294.100
22.	568294.110	568371.100
0.	.000	.000
0.	.000	.000
0.	.000	.000
0.	.000	.000
0.	.000	.000
0.	.000	.000

S-band

TRW id	Start	Stop
108.	566399.100	566769.100
7.	568192.100	568707.100
0.	.000	.000
0.	.000	.000
0.	.000	.000
0.	.000	.000
0.	.000	.000
0.	.000	.000
0.	.000	.000
0.	.000	.000

--- Lear radar id's indexed by TRW radar id's

50	51	3	53	52	13	14	16	17	41
44	20	19	42	54	0	1	46	47	2

8	6	7	4	12	15	45	49	18	21
23	22	28	29	27	5	11	9	10	25
24	26	35	33	30	32	34	38	43	39
40	31	48	0	0	0	0	0	0	0

**************** radselect.in ****************

Number of days is 12

Start time = 564860.000 Stop time = 568800.000

--- Lear radar id's indexed by TRW radar id's

50	51	3	53	52	13	14	16	17	41
44	20	19	42	54	0	1	46	47	2
8	6	7	4	12	15	45	49	18	21
23	22	28	29	27	5	11	9	10	25
24	26	35	33	30	32	34	38	43	39
40	31	48	0	0	0	0	0	0	0

--- p array as written in LRBET5.IN ---

--- ps array as written in LRBET5.IN ---

--- initial state array as in LRBET5.IN ---

***************** rdrpos.in *****************

--- p array as in LRBET5.IN ---

--- ps array as in LRBET5.IN ---

--- number of days is 12.

***************** runbea.in *****************

--- Variables used for runbea ---

Start time = 564860.000 Stop time = 568800.000 Default is -9999.
Print option is 0 (0 is no print; 1 is print)

--- 1 Breakpoints in imu option selection processing ---

pt#	time of break	new option	tolerance
0	564860.000	7	.0500000
1	567000.000	7	.0500000
2	568800.000	--	---

--- Quaternion (stable member to outer roll) ---

imu1	imu2	imu3
.9956973944686318100	.9955721532915802200	.9957302072158107400
-.0000308596631646868	-.0000561511125684124	-.0000724819954709063
-.0926626326362966910	-.0939959459869063730	-.0923041749081765920
.0005910718515623609	.0009270363172491862	.0011411259581097712

--- refsmats are : ---

For orthogonality check see I2IIPC

.6133975386619567900000	-.3773152828216553800000	.6938130855560302700000
.4503512978553768600000	-.5545662045478820800000	-.6997427940368650100000
.6487889885902404800000	.7416801452636716500000	-.1702450513839721100000
.2954440712928772000000	-.0588084608316421510000	-.9535482525825500500000
-.7317413091659600300000	.6277721524239999700000	-.2654369473457300300000
.6142209768295285900000	.7761724591255190200000	.1424389481544494100000
-.5544043183326721200000	.7906298637390134500000	.2598850727081299900000
.1250686645507812500000	-.2295741438865661600000	.9652220010757449600000
.8227962255477999600000	.5676267743110659000000	.0283938609063625440000

```
*****************  spline.in  ****************

 Start time =    564860.000  Stop time =    568800.000
           Number of days of the year is   12.

*****************  statcom.in ****************

 Number of special event flags is =   0

*****************  telmtr.in *****************

 Start time =    564860.000  Stop time =    568800.000
      After   564850.000 use micro-g criteria
      After        .567E+06 use high-g criteria
      Clock bias of onboard clock is      .000000
      Drift rate onboard clock is     .00000000 referenced to       .000000
```

20.2.3.3 Definition of Outputs

GTRACK.IN

GTRACK.IN is a binary file and is used as an input file to GTRACK. It consists of one record with the following elements in the following order:

(1) rnp matrix (double precision) (3,3) (written column major order) - The value of the rotation/nutation/precession matrix calculated at liftoff and presented in column major order.

(2) begin search time (double precision) - the time the program is to begin calculating the ONBOARD file for data.(Normally zero)

(3) end search time (double precision) - the time the program is to end calculating the ONBOARD file for data. (Normally 1d+10)

(4) year of launch (integer) - the year of launch (4 digits)

(5) epoch of launch (double precision) - the time in days since midnight Dec 31 of the previous year (Jan1 = 1).

I2IIPC.IN

I2IIPC.IN is a binary file and is used as the input to I2IIPC. It is made up of multiple records with the following order and definition:

(1) Record 1 consists of one double precision element - SRB ignition seconds - the time in seconds from midnight day of launch.

(2) Record 2 thru xx consists of four double precision elements - each record consists of the four elements of the first index of the cgt array. The first element is time in seconds from ignition(ascent) or seconds from midnight day of launch (descent), elements 2 thru 4 are the X, Y, Z components of cg in feet from the nav base. The number of records is dependent on the number of cg value in the table. The last record will consit of four default words (-9999.0d0).

(3) Record xx+1 thru yy consists of two elements as follows:

   (a) Special event time (double precision) - time in seconds since midnight day of launch to the special event to be recorded.

   (b) Special event time description (70 characters) - The description of the special event to be recorded in words.

The number of records is dependent on the number of Special Events on the mission. The last record will consist of a default word (-9999.0d0) in the special event time and blanks in the special event time description.

(4) Record yy+1 thru zz consists of six double precision elements that

contain of the six elements of the first index of the tracker array. The element descriptions are as follows:

(a) radar station id

(b) geodetic latitude of the radar station

(c) geodetic longitude of the radar station

(d) msl altitude of the radar station

(e) geodetic altitude of the radar station

(f) azimuth of the station (msbls only)

The number of records is dependent on the number of radar stations in the RADAR file plus the two MSBLS stations. The last record will consists of six default words(-9999.d0).

(5) The last record consists of nine elements defined as follows:

(a) delta time (double precision) - The difference in time expressed in seconds between the onboard clock and the ground clock.

(b) guidance release time (double precision) - The time in seconds from midnight day of launch when the guidance system was released to measure the inertial frame(SRB ignition time).

(c) launch direction (double precision) - The launch azimuth of the shuttle in degrees.

(d) launch site longitude (double precision) - The longitude at the launch site measured in degrees.

(e) launch site latitude (double precision) - The latitude at the launch site measured in degrees.

(f) refsmats (double precision) (3,3,3) - the reference matrix of the three imu outer roll to nav base transformations in column, row, imu order.

(f) radius of sub point (double precision) - The radius of the earth at the launch site measured in feet.

(g) nav base altitude (double precision) - The geodetic height of the nav base with respect to the Fisher ellipsoid measured in feet.

(h) nav base to structure translation (double precision) (3) - the three translation numbers to move the structure coordinates to the nav base coordinates, order is x,y,z.

LANDQA.IN

LANDQA.IN is a binary file and is used as the input to LANDQA. It is made up of thirteen elements in one record as follows:

(1) Ascent flag logical - logical flag to indicate ascent(True) or descent(False)

(2) Height of msl (double precision) - The height of the all stop point on the runway in mean sea level feet.

(3) Azimuth (double precision) - The azimuth of the runway in degrees.

(4) Geodetic height (double precision) - The height of the runway with respect to the Fisher ellipsoid in feet.

(5) Geodetic latitude (double precision) - the geodetic latitude of the threshold of the approach end of the runway used for landing in degrees.

(6) Geodetic longitude (double precision) - the geodetic longitude of the

threshold of the approach end of the runway used for landing in degrees.

(7) Equitorial radius (double precision) - The equitorial radius of the earth measured in feet.

(8) Mean-of-50 to ECI transformation matrix (double precision) (3,3) - The mean-of-50 coordinates to eci coordinates transformation matrix values in column major order.

(9) Polar radius (double precision) - The polar radius of the earth measured in feet.

(10) Omega (double precision) - The earth rotation rate measured in radians per second.

(11) P array (double precision) (540) - The p array for the LRBET5 filter.

(12) Touchdown point X (double precision) - The touchdown point on the runway measured from the approach threshold in feet.

(13) Touchdown point Y (double precision) - The touchdown point on the runway measured laterally from the landing gear midpoint to the centerline in feet. (- is left; + is right)

LRBET5.IN

LRBET5.IN is a binary file and is used as an input file for LRBET5. It is composed of four arrays in one record arranged as follows:

(1) cuvw matrix (double precision) (6,6) - The initial covariance matrix written in column major order.

(2) P array (double precision) (540) - The p array for the LRBET5 filter.

(3) PS array (double precision) (372) - the ps array contains the radar

station data for the LRBET5 filter.

(4) x array (double precision) (20) - The x array contains the initial state vector data for LRBET5.

LRRESID.IN

LRRESID.IN is a binary file and is used as an input file for LRRESID. It is composed of four arrays and a number in one record arranged as follows:

(1) cuvw matrix (double precision) (6,6) - The initial covariance matrix written in column major order.

(2) P array (double precision) (540) - The p array for the LRBET5 filter.

(3) PS array (double precision) (372) - the ps array contains the radar station data for the LRBET5 filter.

(4) x array (double precision) (20) - The x array contains the initial state vector data for LRBET5.

(5) number of days (double precision) - The number of days since dec 31 (eg., jan 12 is 12).

MERGE.IN

MERGE.IN is binary and is used as an input file for MERGE. It contains multiple records of the following elements of the size indicated:

(1) Record 1 contains two numbers of the following description:

(a) Start time (double precision) - The start time of the mission measured in seconds from midnight day of launch.

(b) Stop time (double precision) - The stop time of the mission measured in seconds from midnight day of launch.

(2) Record 2 thru xx consists of four double precision elements - each record consists of the four elements of the first index of the cgt array. The first element is time in seconds from ignition(ascent) or seconds from midnight day of launch(descent), elements 2 thru 4 are the X, Y, Z components of cg in feet from the nav base. The number of records is dependent on the number of cg values in the table. The last record will consist of four default words (-9999.0d0).

(3) Record xx+1 thru yy consists of the special event times (double precision) - time of the special event in seconds since midnight day of launch. The number of records is dependent on the number of special events on the mission. The last record will consist of the default word -9999.0d0.

MSBLS.IN

MSBLS.IN is binary and is used as an input file for MSBLS. It contains one record of the following elements of the size indicated:

(1) Start time (double precision) - The start time of the mission measured in seconds from midnight day of launch.

(2) Stop time (double precision) - The stop time of the mission measured in seconds from midnight day of launch.

(3) offset (double precision) - the time in seconds correction to convert onboard time to ground time(normally zero).

(4) drftrt (double precision) - the clock drift rate of the onboard clock (normally zero) measured in seconds per second.

(5) reftm (double precision) - the reference time used with the drift rate to calculate the current time bias. Time is measured in seconds from midnight day of launch.

MSLRRESID.IN

MSLRRESID.IN is binary and is used as an input file for MSLRRESID. It contains one record of the following elements of the size indicated:

(1) P array (double precision) (540) - The p array for the LRBET5 filter.

(2) PS array (double precision) (372) - the ps array contains the radar station data for the LRBET5 filter.

(3) x array (double precision) (20) - The x array contains the initial state vector data for LRBET5.

MSOBRESID.IN

MSOBRESID.IN is binary and is used as an input file for MSOBRESID. It contains one record of the following elements of the size indicated:

(1) P array (double precision) (540) - The p array for the LRBET5 filter.

(2) PS array (double precision) (372) - the ps array contains the radar station data for the LRBET5 filter.

(3) x array (20) - The x array contains the initial state vector data for LRBET5.

(4) number of days (double precision) - The number of days since dec 31 (eg., Jan 12 is 12).

OPIP.IN

OPIP.IN is a binary file and is used as an input file for OPIP. It contains nine records of the following elements of the size indicated:

(1) Record 1 contains 31 elements defined as follows:

(a) Astronomic latitude (double precision) - The astronomic latitude of the launch point in degrees.

(b) Astronomic longitude (double precision) - The astronomic longitude of the launch point in degrees.

(c) Astronomic msl altitude (double precision) - The astronomic msl altitude of the launch point in feet.

(d) Launch azimuth (double precision) - The launch azimuth in degrees.

(e) Geodetic height (double precision) - The geodetic height as measured in feet from the Fisher ellipsoid to the launch point.

(f) Geodetic latitude (double precision) - The geodetic latitude of the launch point in degrees.

(g) Geodetic longitude (double precision) - The geodetic longitude of the launch point in degrees.

(h) Ascent flag logical - logical flag to indicate ascent (True) or descent (False).

(i) Astronomic msl altitude (double precision) - The astronomic msl altitude of the runway in feet.

(j) Astronomic latitude (double precision) - The astronomic latitude of the runway in degrees.

(k) Astronomic longitude (double precision) - The astronomic longitude of the runway in degrees.

(l) Runway (double precision) - The runway azimuth in degrees.

(m) Debug flag logical - logical flag to turn on (True) or turn off (False) the OPIP debug print mode.

(n) delta time (double precision) - The difference in time expressed in seconds between the onboard clock and the ground clock.

(o) Geodetic height (double precision) - The geodetic height as measured in feet from the Fisher ellipsoid to the runway.

(p) Geodetic latitude (double precision) - The geodetic latitude of the runway in degrees.

(q) Geodetic longitude (double precision) - The geodetic longitude of the runway in degrees.

(r) Equitorial radius (double precision) - The equitorial radius of the earth measured in feet.

(s) GMT day (integer) - The day of ignition of the SRBs in days since midnight Dec 31.

(t) GMT seconds (double precision) - The seconds from midnight day of launch to SRB ignition corrected for time biases.

(u) GMT year (integer) - The year of SRB ignition(four digits).

(v) Mean-of-50 to ECI transformation matrix (double precision) (3,3) - The mean-of-50 coordinates to ECI coordinates transformation matrix values in column major order.

(w) CG variances (double precision) (3) - The variances in the CG locations measured is feet.

(x) Polar radius (double precision) - The polar radius of the earth measured in feet.

(y) SRB day (integer) - The day of ignition of the SRBs in days since midnight Dec 31.

(z) SRB seconds (double precision) - The seconds from midnight day of launch to SRB ignition.

(aa) SRB year (integer) - The year of SRB ignition(four digits).

(ab) drftrt (double precision) - the clock drift rate of the onboard clock(normally zero) measured in seconds per second.

(ac) Epoch day (integer) The day of rnp epoch(SRB ignition) in days since midnight Dec 31.

(ac) Epoch year (integer) - The year of rnp epoch(SRB ignition)(four digits).

(ad) Omega (double precision) - The earth rotation rate measured in radians per second.

(2) Record 2 thru 9 consist of the header information for the final delivery tape file. Each record is 80 characters long.

RADAR5.IN

RADAR5.IN is binary and is used as an input file for RADAR5. It contains one record of the following elements of the size indicated:

(1) Start Time (double precision) - the start time of the mission in seconds

from midnight day of launch

(2) Stop Time (double precision) - the stop time of the mission in seconds from midnight day of launch

(3) Cband1 (double precision) (3x10) - an array containing the file id, start time, and stop time for each interval selected to be used in the primary radar(ie., has range,azimuth, and elevation). Capability exists for ten station intervals.

(4) Cband2 (double precision) (3x10) - an array containing the file id, start time, and stop time for each interval selected to be used in the secondary radar(ie., has only range). Capability exists for ten station intervals.

(5) Cband3 (double precision) (3x10) - an array containing the file id, start time, and stop time for each interval selected to be used in the secondary radar(ie., has only range). Capability exists for ten station intervals.

(6) Sband (double precision) (3x10) - an array containing the file id, start time, and stop time for each interval selected to be used in the s-band radar(ie., has range and doppler). Capability exists for ten station intervals.

(7) Station ID (integer) (60) - Lear radar station ID's are presented in the order of the TRWID radar station ID's (i.e., Lear ID 13 for Goldstone radar is the 6th integer value since the TRWID is 6 for the same station). There are 54 stations used allowing 6 expansion slots.

RADSELECT.IN

RADSELECT.IN is binary and is used as an input file to RADSELECT. It contains three records of the following elements of the following size and order:

(1) Record 1 contains day of launch (double precision) - The day of launch measured from midnight Dec 31.

(2) Record 2 contains three elements as follows:

(a) Start Time (double precision) - time in seconds of the start of the mission based on midnight day of launch

(b) Stop Time (double precision) - time in seconds of the stop of the mission based on midnight day of launch

(c) Station ID (integer) (60) - lear radar station ID's are presented in the order of the TRWID radar station ID's (i.e., Lear ID 13 for the Goldstone radar in California is the 6th integer value since the TRWID is 6 for the same station). There 54 stations used allowing 6 expansion slots.

(3) Record 3 contains three elements as follows:

(a) P (double precision) (540) - this array contains all the LRBET5 common variables.

(b) PS (double precision) (372) - this array contains all the radar station position information.

(c) X (double precision) (20) - this array contains the initial state vector of values for LRBET5.

RAECOMP.IN

RAECOMP.IN is a binary file and is used as an input file for RAECOMP. It is composed of four arrays and a number in one record arranged as follows:

(1) cuvw matrix (double precision) (6,6) - The initial covariance matrix written in column major order.

(2) P array (double precision) (540) - The p array for the LRBET5 filter.

(3) PS array (double precision) (372) - the ps array contains the radar station data for the LRBET5 filter.

(4) x array (double precision) (20) - The x array contains the initial state vector data for LRBET5.

(5) number of days (double precision) - The number of days since dec 31 (eg., jan 12 is 12).

RDRPOS.IN

RDRPOS.IN is a binary file and is used as an input file for RDRPOS. It is composed of two arrays and a number in one record arranged as follows:

(1) P array (double precision) (540) - The p array for the LRBET5 filter.

(2) PS array (double precision) (372) - the ps array contains the radar station data for the LRBET5 filter.

(3) number of days (double precision) - The number of days since dec 31 (eg., Jan 12 is 12).

RUNBEA.IN

RUNBEA.IN is a binary file and is used as an input file for RUNBEA. It contains two records of the following variables in the following order:

(1) Record 1 has the refsmats for the three IMU's as follows:

(a) IMU1 refsmat (double precision) (3,3) - The IMU1 refsmat in column major order.

(b) IMU2 refsmat (double precision) (3,3) - The IMU2 refsmat in column major order.

(c) IMU3 refsmat (double precision) (3,3) - The IMU3 refsmat in column major order.

(2) Record 2 has eleven elements described as follows:

(a) number of breakpoints (integer) - The number of specific array points in the breakpoint dependent arrays.

(b) breakpoint times (double precision) (50) - The times identified where changes in imu selection option changes or tolerance values changes are required. Time is in seconds from day of launch.

(c) iopt (integer) (51) - Options selected for each matching time interval for imu quaternian selection criteria.

(d) start time (double precision) - time in seconds of the start of the mission based on midnight day of launch.

(e) stop time (double precision) - time in seconds of the stop of the mission based on midnight day of launch.

(f) default value (double precision) - The default value passed to the program RUNBEA (normally -9999.d0).

(g) breakpoint tolerances (double precision) (51) - Tolerances for each matching time interval for IMU quaternin selection/deletion criteria.

(h) qrolsml (double precision) (4) - quaternion defining the stable member to outer roll transformation for IMU 1.

(i) qrolsm2 (double precision) (4) - quaternion defining the stable member to outer roll transformation for IMU 2.

(j) qrolsm3 (double precision) (4) - quaternion defining the stable member to outer roll transformation for IMU 3.

(k) Print flag logical - logical print flag to print the full print file similar to the binary output file from RUNBEA. True means print the file; false means do not print the file.

SPLINE.IN

SPLINE.IN is a binary file and is used as an input file for SPLINE. It contains one record of the following variables in the following order:

(1) Start Time (double precision) - time in seconds of the start of the mission based on midnight day of launch,

(2) Stop Time (double precision) - time in seconds of the stop of the mission based on midnight day of launch,

(3) Number of days (double precision) - The number of days since Dec 31 (i.e., day of the year) to launch day.

STATCOM.IN

STATCOM.IN is a binary file and is used as an input file for STATCOM. It contains multiple records of the following variables in the following order:

(1) Record 1 contains an integer telling the number of special events that will follow.

(2) Record 2 thru xx each contain two elements described as follows:

(a) Special event name (10 characters) - The special character description of the event to appear on the plot (eg., MECO).

(b) Special event time (double precision) - The time in seconds from midnight day of launch of the special event.

The number of records depends on the numerical value of record #1.

TELMTR.IN

TELMTR.IN is a binary file and is used as an input file for TELMTR. It contains one record of the following variables in the following order:

(1) start (double precision) - the output data start time desired (time is in seconds from midnight day of launch, usually ten seconds prior to ignition for Ascent and ten seconds prior to deorbit burn for Descent).

(2) stp (double precision) - the output data stop time desired (time is in seconds from midnight day of launch, usually ten seconds after OMS-2 cutoff for Ascent and ten seconds after all stop on the runway for Descent)

(3) t1 (double precision) - the time criteria to set the test in TELMTR for when to use the micro-g criteria, i.e., freeflight. For Ascent the time is MECO + ten seconds; for Descent the time is ten seconds prior to deorbit burn ignition. Time is in seconds from midnight day of launch.

(4) t2 (double precision) - The time criteria to set the test in TELMTR for when to use the high-g criteria ie., thrust/aerodrag. For Ascent the time is start time - ten seconds; for Descent the time is Entry Interface (400000ft). Time is in seconds from midnight day of launch.

(5) offset (double precision) - the time in seconds for when to convert onboard time to ground time (normally zero).

(6) drftrt (double precision) - the clock drift rate of the onboard clock (normally zero) in seconds per second.

(7) reftm (double precision) - the reference time used with the drift rate to calculate the time correction to be used (normally zero). Time is in seconds from midnight day of launch.

20.2.3 Execution Procedure

In order to execute INPUT, type in and execute

```
input.x
```

20.2.4 Messages

Screen Displayed Error Messages

When the menu update has been completed and the "q" option has been selected in the MAIN MENU, the following messages are sent to the screen as processing of the files is accomplished:

```
start-stop
imumats
imuselect
refsmats
sband
cgtable
dewpoints
rcv
set
radselect
del_intrvls
```

runwaydata
runway
deorbit_vec
returning m50teci
earth constants
radar
trac complete
writing files

Only one error message may appear with the processing of the above messages as follows:

WARNING MSID FILE DOES NOT EXIST

This message will occur when the MSID file generated from the ILD program is not present in the directory.

Print File Error Messages

Several error messages may be printed to the WRITE66 file as a result of the processing of the inputs as follows:

(1) " the radar input file is missing. "

This message will occur when the file RADAR is not in the production directory. An improper setup of the production directory was accomplished or the file was inadvertantly deleted.

(2) " error - antenna type not specified for station xx "

This message will occur when a s-band station does not have the expected antenna specification (e/w or n/s) for the keyhole data. Reload the RADAR file and verify correct s-band station keyhole data.

(3) " warning - frequency not specified for station xx "

This message will occur when an s-band station does not have a frequency assigned as expected.

(4) "time error for cgt "

This message will occur when the cgt times are not monotonically increasing.

(5) " time error in set above "

This message will occur when the special event times are not monotonically increasing.

(6) " station code xxxx not found in station array "

This message will occur when the dewpoint character id array is not found in the file RADAR.

(7) " ***** Refraction corrected station code xxxx not found *****"

This message occurs when an incorrect station id code is detected in the 16 station corrected id code list in the DEWPOINTS menu.

21.0 LANDQA

21.1 LANDQA FUNCTIONAL DESCRIPTION

LANDQA reads the output of LRBET5, the file "tape9", and plots the final two hundred seconds and one hundred seconds of a descent trajectory. The plots are in landing field coordinates. There are a total of four plots, two with x vs y and two with x vs z. The plots show the touchdown position and the final rollout position.

21.2 LANDQA OPERATIONAL DESCRIPTION

21.2.1 Equipment Configuration

LANDQA uses the standard Ascent/Descent hardware. Make sure the terminal's printer has paper.

21.2.2 Input Items

LANDQA reads two files "tape9" and "landqa.in". The file "tape9" is described in the LRBET5 section.

21.2.2.1 Sample Input

The files "landqa.in" and "tape9" are binary files, so no listings are available.

21.2.2.2 Definition of Inputs

The file "landqa.in" contains the following data

(l logical, d double precision)

name	type	description
ascent	l	flag set to true if ascent
damslh	d	altitude of runway above sea level
dazimu	d	runway azimuth
dgh	d	geodetic height of runway
dglat	d	geodetic latitude of runway
dglong	d	geodetic longitude of runway
eqrad	d	equatorial radius of the earth
m502eci	d(3,3)	transformation matrix from mean of 50 to eci
polrad	d	the polar radius of the earth
wl	d	the rotation rate of the earth
p	d(540)	the p array for a description read the lrbet5 input the values used are the final rollout time and vector
touchx	d	in landing field coordinates it is the x component of the touchdown vector
touchy	d	in landing field coordinates it is the y component of the touchdown vector

21.2.3 Execution Procedure

In order to run LANDQA, the program LRBET5 must be run first. The user then types in and executes

landqa.x

21.2.3.1 Sample Output

The output is four plots

21.2.4 Messages

None.

22.0 LRBET5

22.1 LRBET5 FUNCTIONAL DESCRIPTION

This program is not interactive. The purpose of this program is to generate the filtered best estimate of the trajectory for the ascent or descent trajectory. The program is documented completely in "The Ascent/Entry BET Program, LRBET5", (Document 2, Section 2.1), dated December, 1983. The document fully describes the functions, variables, and formulas used.

22.2 LRBET5 OPERATIONAL DESCRIPTION

LRBET5 is one of the Ascent/Descent configured programs and resides in /users/Adheaven/EXECUTE. The program is used in the shell script, AUTOSELECT and can be executed independently either in the forward or forward/backward modes. The inputs are the files LRBET5.IN, TAPE10, TAPE11, TAPE12, TAPE13, TAPE14, and for descent, also TAPE16, TAPE17, and TAPE18. The outputs are LRBET66, a formatted file of the inputs and outputs, and TAPE9, a binary file of the outputs. There are numerous options and various switches in the inputs to modify the outputs. Changes to the standard execution requires extensive knowledge of the filter and its operation and modification to the standard execution program are not recommended for the novice. The variables accessable to change are available in the RARELY CHANGED VARIABLES menu in the INPUT program.

22.2.1 Equipment Configuration

The program must be executed in the directory where the input files are located. The input files are LRBET5.IN, TAPE10 through TAPE14 and on descent also TAPE16 through TAPE17. Output files will be generated in the directory of execution.

22.2.2 Input Items

22.2.2.1 Sample Input

All the input files are binary.

22.2.2.2 Definition of Inputs

LRBET5.IN

LRBET5.IN is a namelist file containing four array variables, CUVW,P, PS, and X. The order and size of the file is as follows:

(1) CUVW (double precision) (6x6) - this array contains the initial guess at the covariance matrix. Variables are stored in row order first.

(2) P (double precision) (540) - this array contains all the LRBET5 common variables.

(3) PS (double precision) (372) - this array contains all the radar station position information.

(4) X (double precision) (20) - this array contains the initial state vector of values for LRBET5.

TAPE10

TAPE10 is a file of IMU records generated as an output of TELMTR. It contains records of the three IMU components for each IMU. The time in the last two records is 1.0d31. Each record contains the following data in the order presented:

(1) Time (double precision) - time of the record in seconds from midnight day of launch.

(2) Delta time (double precision) - the time interval from the last record to the present record in seconds.

(3) IMU value of acceleration (double precision) - the acceleration values of the three components of IMU1 in order X,Y,Z; followed by IMU2 and IMU3 in the same component order. There are nine components measured in meters per second squared.

TAPE11, TAPE12, TAPE13

These three files are input files used in the LRBET5 process and represent the C-band radar inputs to the filter. The records contain the following elements as ordered:

(1) Time (double precision) - time in seconds measured from midnight day of launch.

(2) Station ID (integer) - the radar station TRWID as collected from the raw data file.

(3) C-band range (double precision) - the range measurement in meters as measured at time(1).

(4) C-band azimuth (double precision) - the azimuth measurement in radians as measured at time(1).

(5) C-band elevation (double precision) - the elevation measurement in radians as measured at time(1).

TAPE14

TAPE14 is an input file similar to TAPE11, TAPE12, and TAPE13 used in the LRBET5 process. This file represents the S-band radar inputs to the filter. The records contain the following elements as ordered:

(1) Time (double precision) - time in seconds measured from midnight day of launch.

(2) Station ID (integer) - the radar station TRWID as collected from the data file.

(3) S-band range (double precision) - the range measurement in meters as measured at time(1).

(4) S-band doppler counts (integer) - the doppler counts in frequency shift in cycles as measured at time(1).

TAPE16 (Descent only)

TAPE16 is a file of MSBLS range records generated out of MSBLS. It contains the time of the record and the range value. The record is as follows:

(1) time (double precision) - the time of the record in seconds since midnight day of launch,

(2) MSBLS range (double precision) - the MSBLS range at the time of the record measured in meters.

TAPE17 (Descent only)

TAPE17 is a file of MSBLS azimuth records generated out of MSBLS. It contains the time of the record and the azimuth value. The record is as follows:

(1) Time (double precision) - the time of the record in seconds since midnight day of launch,

(2) MSBLS azimuth (double precision) - the MSBLS azimuth at the time of the record measured in radians.

TAPE18 (Descent

TAPE18 is a file of MSBLS wedge records generated out of MSBLS. It contains the time of the record and the wedge value. The record is as follows:

(1) Time (double precision) - the time of the record in seconds since midnight day of launch,

(2) MSBLS wedge (double precision) - the MSBLS wedge at the time of the record measured in radians.

22.2.3 Execution Procedure

Normal setup of the production directory will copy the current version of the executable LRBET5 program. Independent execution is accomplished by typing in and executing

```
lrbet5.x
```

Runtime varies depending on the forward, forward/backward selection and wheather the run is ascent or descent. A forward only run is executed in approximately 15 to 20 minutes. A forward/backward execution of ascent is approximately 3 hours, while a descent run is approximately 4 hours. The variance is dependent on the time of the mission and the number of radars used.

22.2.3.1 Sample Output

LRBET66

The following is a compressed sample of the formatted output, LRBET66:

n	cn0
1	.0000000000E+00
2	-.1082626800E-02
3	.2535640000E-05
4	.1623360000E-05
5	.2275900000E-06
6	-.5433600000E-06
7	.3606500000E-06
8	.2070200000E-06
9	.1200400000E-06
10	.2410900000E-06

n	m	cnm	snm
1	1	.0000000000E+00	.0000000000E+00
2	1	.1340000000E-08	-.3140000000E-08
3	1	.2191080000E-05	.2721600000E-06
4	1	-.5077400000E-06	-.4451800000E-06
5	1	-.4381900000E-07	-.8031700000E-07
6	1	-.5738100000E-07	.1822200000E-07
7	1	.1979420000E-06	.7462700000E-07
8	1	.1450600000E-07	.3782300000E-07
9	1	.1029650000E-06	.5400000000E-08
10	1	.5490200000E-07	-.8047100000E-07
2	2	.1571170000E-05	-.9031000000E-06
3	2	.3049200000E-06	-.2129500000E-06
4	2	.7872700000E-07	.1484840000E-06
5	2	.1054290000E-06	-.5303200000E-07

6	2	.6139000000E-08	-.4402300000E-07
7	2	.3230800000E-07	.1077000000E-07
8	2	.5816700000E-08	.4486200000E-08
9	2	.1891700000E-08	-.2473500000E-08
10	2	-.5076600000E-08	-.7819000000E-09
3	3	.9764900000E-07	.1969640000E-06
4	3	.5907400000E-07	-.1205900000E-07
5	3	-.1543100000E-07	-.6705300000E-08
6	3	.1181200000E-08	.6880000000E-10
7	3	.3255100000E-08	-.3044700000E-08
8	3	-.1148500000E-09	-.8652200000E-09
9	3	-.1224040000E-08	-.6842000000E-09
10	3	-.1095500000E-09	-.9366000000E-09
4	4	-.4126700000E-08	.6313900000E-08
5	4	-.2238900000E-08	.3885000000E-09
6	4	-.3800200000E-09	-.1747260000E-08
7	4	-.6042500000E-09	-.2757200000E-09
8	4	-.3187200000E-09	.9798000000E-10
9	4	-.8361000000E-11	.1161200000E-10
10	4	-.5722900000E-10	-.4515000000E-10
5	5	.3845300000E-09	-.1624660000E-08
6	5	-.2084900000E-09	-.4336400000E-09
7	5	.5302000000E-11	.1526100000E-10
8	5	-.2910500000E-11	.1492330000E-10
9	5	-.7395000000E-12	-.5745100000E-11
10	5	-.4046500000E-11	-.1961200000E-11
6	6	.6310000000E-12	-.5641100000E-10
7	6	-.2510600000E-10	.9061000000E-11
8	6	-.2090200000E-11	.8930800000E-11
9	6	.5247000000E-12	.2862800000E-11
10	6	-.2691000000E-12	-.5890800000E-12

```
   7    7     -.1330100000E-12      .3131300000E-12
   8    7      .3381700000E-12      .3926300000E-12
   9    7     -.1966300000E-12     -.1425000000E-12
  10    7      .3266000000E-14      .1515900000E-13

   8    8     -.1563100000E-12      .1642800000E-12
   9    8      .6517200000E-13     -.3994000000E-14
  10    8      .4981500000E-14     -.7958500000E-14

   9    9     -.4268800000E-14      .7008400000E-14
  10    9      .2298900000E-14     -.9014000000E-15

  10   10      .4201500000E-15     -.9257000000E-16

                                      the cuvw matrix is
.100000E-01  .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00
.000000E+00  .100000E-01  .000000E+00  .000000E+00  .000000E+00  .000000E+00
.000000E+00  .000000E+00  .100000E-01  .000000E+00  .000000E+00  .000000E+00
.000000E+00  .000000E+00  .000000E+00  .100000E-03  .000000E+00  .000000E+00
.000000E+00  .000000E+00  .000000E+00  .000000E+00  .100000E-03  .000000E+00
.000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00  .100000E-03

id  ips                                the ps values are
 1    1  .2992152E+0 .5204703E+1 -.3310000E+2  .000000E+0  .175900E+5  .00000E+0
 2    7  .5645802E+0 .5154771E+1 -.3525000E+2  .335531E-3  .731000E+4  .00000E+0
 3   13  .5646382E+0 .5154693E+1 -.3375000E+2  .335531E-3  .730718E+4  .2106E+10
       --- etc., ps array ---
61  361  .0000000E+0 .0000000E+0  .0000000E+0  .000000E+0  .000000E+0  .00000E+0
62  367  .0000000E+0 .1759000E+5  .3141592E+1  .314159E+1  .000000E+0  .00000E+0

                   at ts= .0000000000E+00 the zs and zds vectors are
.000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00
.000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00

.000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00
.000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00
```

```
                    the first 300 elements of the p(540) array are
  1 .572957E+02  .100000E+02  .100000E-03  .100000E+01  .180000E+04  .300000E+02
  7 .200000E+01  .299792E+09  .729211E-04  .637813E+07  .108262E-02  .398600E+15
 13 .490278E+13  .132712E+21  .398615E+15  .637816E+07  .335232E-02  .637800E+07
         --- etc., p array ---
289 .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00
295 .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00

                  at t= .4289000000E+05 the initial state vector is
-.4874989E+7 -.2744607E+7  .3052948E+7  .2001432E+3 -.3562634E+3 -.6902031E+0
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0

    sl doppler residual edit at t= .4291300000E+05 seconds for station id=20
    sl doppler residual edit at t= .4291500000E+05 seconds for station id=20
    sl doppler residual edit at t= .4291600000E+05 seconds for station id=20
               -- etc., edits and too low deletions from LRBET5  --
    sl elevation angle too low at t= .4355900000E+05 seconds for station id= 3
    cl elevation angle too low at t= .4356000000E+05 seconds for station id= 2
    sl elevation angle too low at t= .4356000000E+05 seconds for station id= 3

           the total number of mass storage records is nms=2931.

the state vector time tag is = .4582000000E+05 seconds.
the kalman filter state vector and its sigmas are
.5316825E+7  .2538585E+7 -.3197343E+7 -.3484432E+4  .6873798E+4 -.3394469E+3
.5450E+03    .5677E+03    .1409E+03    .7646E+00    .1471E+00    .4157E+00
      imu misalinements                   cl biases           c2 bias    c3 bias
 .2447E-3 -.3853E-3 -.1283E-5  -.1307E+0 .1566E-7 .6856E-7  .3883E-1   .0000E+0
 .5820E-3  .5857E-3  .5792E-3   .3231E+2 .9652E-4 .1474E-3  .3231E+2   .3231E+2

      sl biases              tdrs                      mls biases
 -.5471E-1 -.1908381E+8    .0000000E+0     .0000E+0    .0000E+0    .0000E+0
  .2800E+2  .4836172E+1    .1000000E+33    .8000E+1    .3500E-3    .3500E-3
```

geod lat=-28.460deg long= 83.304deg alt=178.23n.mi. semimaj axis a=6708341.6m sig a= .23857E+3m

the smoothing filter state vector and its sigmas are

.5316825E+7	.2538585E+7	-.3197343E+7	-.3484432E+4	.6873798E+4	-.3394469E+3
.5450E+3	.5677E+3	.1409E+3	.7646E+0	.1471E+0	.4157E+0

imu misalinements			c1 biases			c2 bias	c3 bias
.2447E-3	-.3853E-3	-.1283E-5	-.1307E+0	.1566E-7	.6856E-7	.3883E-1	.0000E+0
.5820E-3	.5857E-3	.5792E-3	.3231E+2	.9652E-4	.1474E-3	.3231E+2	.3231E+2

s1 biases		tdrs		mls biases	
-.5471E-1	-.1908381E+8	.000000E+0	.0000E+0	.0000E+0	.0000E+0
.2800E+2	.4836172E+1	.100000E+33	.8000E+1	.3500E-3	.3500E-3

geod lat=-28.460deg long= 83.304deg alt=178.23n.mi. semimaj axis a=6708341.6 m sig a= .23857E+3m

as= .000 .000 .000 attl= -7.036 -3.356 4.242

the cuvw matrix is

.3033442E+3	-.7950548E+0	.1373509E-1	.9175365E+0	-.9411076E+0	-.8520926E-1
.0000000E+0	.7348932E+3	-.2073181E-1	-.9624870E+0	.8308018E+0	.1497223E+0
.0000000E+0	.0000000E+0	.8447831E+2	.1712497E-1	-.1674600E-1	-.1360401E+0
.0000000E+0	.0000000E+0	.0000000E+0	.8350677E+0	-.9001896E+0	-.1304887E+0
.0000000E+0	.0000000E+0	.0000000E+0	.0000000E+0	.2588088E+0	.9464654E-1
.0000000E+0	.0000000E+0	.0000000E+0	.0000000E+0	.0000000E+0	.1213873E+0

the position and velocity differences are

.000000E+0	.000000E+0	.000000E+0	.000000E+0	.000000E+0	.000000E+0

the state vector time tag is = .4581000000E+05 seconds.

----- etc., continued state vectors of the same format ----

22.2.3.2 Definition of Outputs

TAPE9

TAPE9 is the primary output of the LRBET5 process. TAPE9 is calculated using the radar selection input in TAPE11 through TAPE14. This file contains the LRBET5 output products consisting of identical records with the ordered elements as defined below:

(1) Time (double precision) - this is the time of the state vector measured in seconds from midnight day of launch.

(2) State vector (20) (double precision) - this is an array of the filter calculated state vector with (1-3) position components (X,Y,Z) in mean of 50 coordinates measured in meters; (4-6) velocity components ($\dot{X},\dot{Y},\dot{Z}$) in mean of 50 coordinates measured in meters/second; (7-9) IMU misalignment of the X,Y,Z components in mean of 50 coordinates measured in radians; (10) C-band1 range bias measured in meters; (11) C-band1 azimuth bias measured in radians; (12) C-band1 elevation bias measured in radians; (13) C-band2 range bias measured in meters; (14) C-band3 range bias measured in meters; (15) S-band range bias measured in meters; (16) S-band Doppler integration constant measured in meters; (17) S-band Doppler integration constant measured in cycles; (18) MSBLS range bias measured in meters; (19) MSBLS azimuth bias measured in radians; (20) MSBLS wedge angle bias measured in radians.

(3) sensed acceleration(3) (double precision) - the sensed acceleration components ($\ddot{X},\ddot{Y},\ddot{Z}$) as calculated by the filter in mean of 50 coordinates and measured in meters per second squared.

(4) covariance matrix(20x20) (double precision) - the state vector covariance matrix as defined by (2) above.

(5) total acceleration(3) (double precision) - the totaled acceleration components ($\ddot{X},\ddot{Y},\ddot{Z}$) as calculated by the filter and modified by gravity in

mean of 50 coordinates and measured in meters per second squared.

(6) TDRSS components(25) (double precision) - 25 TDRSS components that are not used by any program to date.

22.2.3 Execution Procedure

Type in and execute

lrbet5.x

22.2.4 Messages

The program outputs two messages to the screen as follows:

(1) "p(121) = 0"

This message identifies that the run was a forward only execution and the proper flag, "p(121)", was set to zero.

(2) "p(122) = 0"

This message identifies that the run did not generate an output file of TAPE9. Flag "p(122)" was set to zero which is not the standard setup configuration.

The following error message may occur in the LRBET66 printout:

"the cs matrix was not positive semidefinite"

A check is made on the covariance matrix and if it is not positive semidefinite, then the message appears in the output. In any event, the covariance matrix is made positive semidefinite before processing is continued.

23.0 LRRESID

23.1 LRRESID FUNCTIONAL DESCRIPTION

LRRESID is an analysis program used to evaluate the radar data relative to the LRBET5 output trajectory. The program initializes with the LRBET5 trajectory and translates that Mean-of-50 coordinates position to the equivalent range, azimuth, and elevation of an available radar station. Differences in the actual values of the radar station and the translated values are calculated and stored. In addition, the difference in the two position vector magnitudes is calculated and the four time tagged items are saved in an output file. When all the avaiable radar stations have been used the program terminates. The difference files are used as inputs to a plot routine. The functions of the program are as follows:

(1) Initialize LRBET5 trajectory

(2) Open and read the first radar file

(3) calculate the range, azimuth, elevation using the base radar station coordinates.

(4) Calculate the differences in range, azimuth, elevation, distance, and Doppler(s-band only).

(5) Save the differences and cycle to the next position.

(6) After completion of one radar station data file, cycle to the next radar station file and repeat steps (1) to (5).

23.2 LRRESID OPERATIONAL DESCRIPTION

The normal setup of a flight directory will preload the executable code, but this program is not a part of the mainstream of Ascent/Descent production flow. This program aids the user in evaluating one radar station selection against another. Execution should occur in the directory where the input files are.

23.2.1 Equipment Configuration

There is no special configuration other than normal setup procedures and proper execution of prerequisite programs.

23.2.2 Input Items

Input consists of the files LRRESID.IN, TAPE9, RAEPOS(i), and TABLE. The proper execution of INPUT will generate the input file, LRRESID.IN. The proper execution of a short LRBET5 run will generate the input file TAPE9. The proper execution of RDRMRG will generate the RAEPOS(i) files and the file TABLE

23.2.2.1 Sample Input

LRRESID.IN

LRRESID.IN is a binary file from the menu driven input routine.

TABLE

TABLE is a binary file of the table of radars id's, start time, and stop time of each station on the raw radar tape.

RAEPOS(i)

RAEPOS(i) are individual radar station files of the data from each station.

Basically it is unblocked and separated radar data by station. The files are binary.

TAPE9

TAPE9 is a binary file that is the primary output of the LRBET5 filter. It contains the trajectory that is compared to the radar data.

23.2.2.2 Definition of Inputs

LRRESID.IN

LRRESID.IN is a binary file and is an input file for LRRESID. It is composed of four arrays and a number in one record arranged as follows:

(1) CUVW matrix (double precision) (6,6) - The initial covariance matrix written in column major order.

(2) P array (double precision) (540) - The p array for the LRBET5 filter.

(3) PS array (double precision) (372) - the ps array contains the radar station data for the LRBET5 filter.

(4) X array (double precision) (20) - The x array contains the initial state vector data for LRBET5.

(5) Number of days (double precision) - The number of days since Dec 31 (eg., Jan 12 is 12).

TABLE

This file is an intermediate file used to pass information from RDRMRG to

LRRESID. It is left in the directory for malfuntion analysis and information purposes. It is composed of two different records: (1) The first is only one record long and consists of only one integer number. That number is the number of radar stations detected. Also, it is the same as the number of RAEPOS(i) files present. (2) The second record type has three numbers in it all double precision. This record type gives the following information on each radar station:

- o Station ID - the radar station ID (TRWID) is presented.
- o Start Time - the start time of the data from the radar station is presented in seconds from midnight day of launch.
- o Stop Time - the stop time of the data from the radar station is presented in seconds from midnight day of launch.

RAEPOS(i)

These files are generated in the process of reading the radar files from the raw radar tape file. There is one file for each radar station on the raw radar tape file. Each file is a series of multiple records in the same format. The format is as follows:

(1) Station ID number (double precision) - the TRWID number of the radar station. Numbers under 100 are high rate (tenth second data) stations. Stations over 100 are low rate stations and are normally S-band stations.

(2) Time (double precision) - the time tag of the data on the record. The data is time taged in seconds from midnight the day of launch.

(3) Azimuth (double precision) - this measurement is an azimuth angle measurement. Measurements are in radians.

(4) Elevation (double precision) - this measurement is an elevation angle measurement. Measurements are in radians.

(5) Range (double precision) - the range measurement for that time interval. Data is measured in feet.

(6) Doppler counts (double precision) - this measurement is the doppler counts for the S-band stations; it has no value for a C-band station. This measurement is dimensionless.

TAPE9

TAPE9 is the primary output of the LRBET5 process. This file contains the LRBET5 output products consisting of identical records with ordered elements as defined below:

(1) Time (double precision) - this is the time of the state vector measured in seconds from midnight day of launch.

(2) State vector (double precision) (20) - this is an array of the filter calculated state vector with (1-3) position components (X,Y,Z) in mean of 50 coordinates measured in meters; (4-6) velocity components ($\dot{X},\dot{Y},\dot{Z}$) in mean of 50 coordinates measured in meters/second; (7-9) IMU misalignment of the X,Y,Z components in mean of 50 coordinates measured in radians; (10) C-band1 range bias measured in meters; (11) C-band1 azimuth bias measured in radians; (12) C-band1 elevation bias measured in radians; (13) C-band2 range bias measured in meters; (14) C-band3 range bias measured in meters; (15) S-band range bias measured in meters; (16) S-band Doppler integration constant measured in meters; (17) S-band Doppler integration constant measured in cycles; (18) MSBLS range bias measured in meters; (19) MSBLS azimuth bias measured in radians; (20) MSBLS wedge angle bias measured in radians.

(3) Sensed acceleration (double precision) (3) - the sensed acceleration components ($\ddot{X},\ddot{Y},\ddot{Z}$) as calculated by the filter in mean of 50 coordinates and measured in meters per second squared.

(4) Covariance matrix (double precision) (20x20) - the state vector covariance matrix as defined by (2) above.

(5) Total acceleration (double precision) (3) - the totaled acceleration components ($\ddot{X},\ddot{Y},\ddot{Z}$) as calculated by the filter and modified by gravity in mean of 50 coordinates and measured in meters per second squared.

(6) TDRSS components (double precision) (25) - 25 TDRSS components that are not used as of this date.

23.2.3 Execution Procedure

Normal setup of the production directory will copy the executable current version into the directory. Execution is accomplished by entering

```
lrresid.x
```

Run time is approximately 5 minutes per radar station file.

23.2.3.1 Sample Output

RESID66

The following is a sample of the formatted file RESID66:

```
                         the cuvw matrix is
 .132000E+03  .000000E+00  .000000E+00  .000000E+00 -.940000E+00  .000000E+00
 .000000E+00  .100000E+04  .000000E+00 -.990000E+00  .000000E+00  .000000E+00
 .000000E+00  .000000E+00  .660000E+02  .000000E+00  .000000E+00  .000000E+00
 .000000E+00  .000000E+00  .000000E+00  .115000E+01  .000000E+00  .000000E+00
 .000000E+00  .000000E+00  .000000E+00  .000000E+00  .120000E+00  .000000E+00
 .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00  .800000E-01
```

```
TRW id     Start          Stop
       7.      568192.70      568707.90
      22.      568062.30      568802.00
      23.      568024.10      568351.70
      29.      567151.40      567483.50
      37.      568015.70      568734.90
      39.      567377.10      568744.30
      40.      568047.20      568360.20
     108.      566400.00      566770.00

  i   ips                  the ps values are
  1     1  .299215E+0  .520470E+01 -.33100E+2  .0000E+0  .175900E+5  .000000E+00
  2     7  .564580E+0  .515477E+01 -.35250E+2  .3410E-3  .714115E+4  .000000E+00
  3    13  .564638E+0  .515469E+01 -.33750E+2  .3410E-3  .713816E+4  .210638E+10

           --- (etc., For 60 radar stations from the file RADAR) ---

 60   355  .000000E+0  .000000E+00  .00000E+0  .0000E+0  .000000E+0  .000000E+00
 61   361  .608971E+0 -.205787E+01  .64634E+3  .6092E+0 -.205723E+1  .641728E+03
 62   367  .000000E+0  .175900E+05  .41576E+1  .4158E+1  .000000E+0  .000000E+00

index                the P array values are

  1 .572957E+02  .100000E+02  .100000E-03  .100000E+01  .180000E+04  .300000E+02
  7 .200000E+01  .299792E+09  .729211E-04  .637813E+07  .108262E-02  .398600E+15
 13 .490278E+13  .132712E+21  .398615E+15  .637816E+07  .335232E-02  .637800E+07

               --- (etc., For the rest of the P array) ---

283 .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00
289 .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00
295 .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00

               at t= .5648600000E+06 the initial state vector is
 .5846678E+7 -.6973020E+6 -.3201586E+7  .1075824E+4  .7636811E+4  .3181832E+3
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0
```

```
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0

 First OB tape record has time =     564863.000
 5849896.40199830   -674452.01262228  -3200632.67141539
    1052.73141108      7639.47589903       330.82469581

                    at t= .5648630000E+06 the initial state vector is
 .5849896E+7 -.6744520E+6 -.3200632E+7  .1052731E+4   .7639475E+4   .3308246E+3
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0   .0000000E+0   .0000000E+0
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0   .0000000E+0   .0000000E+0
 .0000000E+0  .0000000E+0

ID=  7 time=  568192.7 az= -1.878 el=  .074 rng=    372964.0 cnts=3553202754517.
idcl=  7 idcll=  7 learid= 14 idin=  7.
initial ips=  79

      *** Completed radar station     7

First OB tape record has time =     564863.000
5849896.40199830   -674452.01262228  -3200632.67141539
   1052.73141108      7639.47589903       330.82469581

                 at t= .5648630000E+06 the initial state vector is
 .5849896E+7 -.6744520E+6 -.3200632E+7  .1052731E+04  .7639475E+4  .3308246E+3
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+00  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0  .0000000E+0  .1000000E+65  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0

ID= 22 time=  568062.3 az=  4.278 el=  .126 rng=    319218.4 cnts=    -9999.
idcl= 22 idcll= 22 learid=  6 idin=  22.
initial ips=  31

      *** Completed radar station    22

First OB tape record has time =     564863.000
```

```
5849896.40199830   -674452.01262228  -3200632.67141539
   1052.73141108      7639.47589903       330.82469581

                  at t= .5648630000E+06 the initial state vector is
 .5849896E+7 -.6744520E+6 -.3200632E+7  .1052731E+04  .7639475E+4  .3308246E+3
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+00  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0  .0000000E+0  .1000000E+65  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0

ID= 23 time=  568024.1 az=  4.291 el=  .080 rng=    428932.1 cnts=      -9999.
idcl= 23 idcll= 23 learid=  7 idin=  23.
initial ips=  37

     *** Completed radar station    23

First OB tape record has time =      564863.000
5849896.40199830   -674452.01262228  -3200632.67141539
   1052.73141108      7639.47589903       330.82469581

                  at t= .5648630000E+06 the initial state vector is
 .5849896E+7 -.6744520E+6 -.3200632E+7  .1052731E+04  .7639475E+4  .3308246E+3
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+00  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0  .0000000E+0  .1000000E+65  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0

ID= 29 time=  567151.4 az=  5.021 el=  6.158 rng=  1953254.8 cnts=      -9999.
idcl=   29 idcll=   29 learid=   18 idin=    29.
initial ips=   103

     *** Completed radar station    29

First OB tape record has time =      564863.000
5849896.40199830   -674452.01262228  -3200632.67141539
   1052.73141108      7639.47589903       330.82469581

                  at t= .5648630000E+06 the initial state vector is
```

```
.5849896E+7 -.6744520E+6 -.3200632E+7  .1052731E+04  .7639475E+4  .3308246E+3
.0000000E+0  .0000000E+0  .0000000E+0  .0000000E+00  .0000000E+0  .0000000E+0
.0000000E+0  .0000000E+0  .0000000E+0  .1000000E+65  .0000000E+0  .0000000E+0
.0000000E+0  .0000000E+0

ID= 37 time=   568015.7 az=  4.401 el=  .021 rng=   697017.4 cnts=     -9999.
idcl=   37 idcll=  37 learid=   11 idin=     37.
initial ips=   61

    *** Completed radar station    37

     --- (etc., for the remainder of the radar stations) ---
```

23.2.3.2 Definition of Outputs

RESIDU(i)

These files are input files to the QA plot process which evaluate the radar selection. These files contain the residuals for the radar to filter trajectory differences. The records are identical and of the following format:

(1) Radar station ID (double precision) - the ID of the radar station used in this difference record.

(2) Time (double precision) - time of the difference measurement measured in seconds from midnight day of launch.

(3) Range difference (double precision) - the difference in range as measured by the radar and the base trajectory at the same time (meters).

(4) Azimuth difference (double precision) - the difference in azimuth as measured by the radar and the base trajectory at the same time (radians).

(5) Elevation difference (double precision) - the difference in elevation as

measured by the radar and the base trajectory at the same time (radians).

(6) Distance difference (double precision) - the difference in distance of the radius vector of the two positions as measured by the radar and the base trajectory at the same time (meters).

(7) Doppler difference (double precision) - the difference in doppler range measurement as calculated by the process from radar and the base trajectory at the same time (meters).

23.2.4 Messages

None.

24.0 MERGE

24.1 MERGE FUNCTIONAL DESCRIPTION

This program is not interactive. Its purpose is to merge the IMU quaternion data with the trajectory state values at standard times. The following specific functions are accomplished by MERGE.

(1) Initialize the start/stop times for the mission, the CG data, and the special event times.

(2) Read the first two records from the filter data and the first three records of the quaternion data.

(3) Interpolate all the data to a common time, i.e., at a special event time or an even second.

(4) Generate the output products for all data not interpolated.

(5) Save the output record.

(6) Close the files when stop time occurs or any input file stops.

24.2 MERGE OPERATIONAL DESCRIPTION

MERGE is one of the Ascent/Descent configured programs and resides in /users/Adheaven/EXECUTE. The program requires that RUNBEA must have been successfully executed generating the file, BEADATA. THe program also requires that a forward/backward LRBET5 must have successfully generated the file, TAPE9. The file, MERGE.IN, generated from a successful completion of INPUT must be in the production directory. The program generates two files, TRJATTDATA and MERGE66. TRJATTDATA is the primary output data file. MERGE66 is a formatted debug file. TRJATTDATA is the primary input file to OPIP.

24.2.1 Equipment Configuration

The standard Ascent/Descent configuration is required.

24.2.2 Input Items

24.2.2.1 Sample Input

The three input files MERGE.IN, BEADATA, and TAPE9 are all binary.

24.2.2.2 Definition of Inputs

MERGE.IN

MERGE.IN is binary file and is used as an input file for MERGE. It contains multiple records of the following elements of the size indicated:

(1) Record 1 contains two numbers of the following description:

   (a) Start time (double precision) - The start time of the mission measured in seconds from midnight day of launch.

   (b) Stop time (double precision) - The stop time of the mission measured in seconds from midnight day of launch.

(2) Record 2 thru xx consists of four double precision elements - each record consists of the four elements of the first index of the cgt array. The first element is time in seconds from ignition (ascent) or seconds from midnight day of launch (descent), elements 2 thru 4 are the X, Y, Z components of cg in feet from the nav base. The number of records is dependent on the number of cg values in the table. The last record will

consist of four default words (-9999.0d0).

(3) Record xx+1 thru yy consists of the special event times (double precision) - time in seconds since midnight day of launch of the special event time. The number of records is dependent on the number of special events on the mission. The last record will consist of the default word -9999.0d0.

BEADATA

BEADATA is one of the primary binary input to MERGE. It is composed of multiple records in the following format:

(1) Time (double precision) - The time of the stable member to roll quaternion in seconds from midnight day of launch.

(2) IOPTV (integer) - User option selection currently in use at this time.

(3) ISTAT (integer) - Selected status of the best estimate quaternion.

(4) BEQ (double precision) (4) - The Best Estimate of the quaternion for the transformation from Mean-of-50 to body axis coordinates measured in radians.

24.2.2.2.3 TAPE9

TAPE9 is a primary input to the MERGE process. TAPE9 is generated using the radar selection based on the last execution of the LRBET5 filter process. This file contains the LRBET5 output product consisting of identical records with the ordered elements as defined below:

(1) Time (double precision) - this is the time of the state vector measured in seconds from midnight day of launch.

(2) State vector (20) (double precision) - this is an array of the filter calculated state vector with (1-3) position components (X,Y,Z) in mean of 50 coordinates measured in meters; (4-6) velocity components ($\dot{X},\dot{Y},\dot{Z}$) in mean of 50 coordinates measured in meters/second; (7-9) IMU misalignment of the X,Y,Z components in mean of 50 coordinates measured in radians; (10) C-band1 range bias measured in meters; (11) C-band1 azimuth bias measured in radians; (12) C-band1 elevation bias measured in radians; (13) C-band2 range bias measured in meters; (14) C-band3 range bias measured in meters; (15) S-band range bias measured in meters; (16) S-band Doppler integration constant measured in meters; (17) S-band Doppler integration constant measured in cycles; (18) MSBLS range bias measured in meters; (19) MSBLS azimuth bias measured in radians; (20) MSBLS wedge angle bias measured in radians.

(3) Sensed acceleration (3) (double precision) - the sensed acceleration components ($\ddot{X},\ddot{Y},\ddot{Z}$) as calculated by the filter in mean of 50 coordinates and measured in meters per second squared.

(4) Covariance matrix (20x20) (double precision) - the state vector covariance matrix as defined by (2) above.

(5) Total acceleration (3) (double precision) - the total acceleration components ($\ddot{X},\ddot{Y},\ddot{Z}$) as calculated by the filter and modified by gravity in mean of 50 coordinates and measured in meters per second squared.

(6) TDRSS components(25) (double precision) - 25 TDRSS components that are not used by any program to date.

24.2.3 Execution Procedure

Normal setup of the production directory will copy the current version of the executable MERGE program. Execution is accomplished by typing and executing

```
merge.x
```

Runtime is approximately 2 minutes.

24.2.3.1 Sample Output

24.2.3.1.1 MERGE66

The following is an abbreviated sample of the formatted debug file, MERGE66:

```
 error - attempted to propagate bea data beyond legal 5 second excess interval
         time=   .56595500D+06 , excess=   -.700532010616735D+01

 error - attempted to propagate bea data beyond legal 5 second excess interval
         time=   .56595600D+06 , excess=   -.600532010616735D+01

 error - attempted to propagate bea data beyond legal 5 second excess interval
         time=   .56595700D+06 , excess=   -.500532010616735D+01


 --- (etc., Error messages where attempts were made to propagate too far) ---


 error - attempted to propagate bea data beyond legal 5 second excess interval
         time=   .56873400D+06 , excess=   -.240532024262939D+01

 error - attempted to propagate bea data beyond legal 5 second excess interval
         time=   .56873500D+06 , excess=   -.236532024247572D+01

 error - attempted to propagate bea data beyond legal 5 second excess interval
         time=   .56873600D+06 , excess=   -.136532024247572D+01
```

24.2.3.2 Definition of Outputs

TRJATTDATA

TRJATTDATA is the primary output file of MERGE. It is used as the input for the OPIP program. It is composed of multiple identical records of the following form and order:

(1) Special event pointer (integer) - Pointer to the special event time this record represents(ie., 0 = normal output time; integer number index of the special event array).

(2) Time (double precision) - time of the record in seconds from midnight day of launch.

(3) State vector (double precision) (18) - The state vector at the time of the record. Data is in Mean of 50 coordinates system. Items (1-3) are position(x,y,z) in feet; items (4-6) are velocity ($\dot{x},\dot{y},\dot{z}$) in feet/second; items (7-9) are sensed acceleration in feet/second squared; items (10-12) are euler angles in radians; items (13-15) are euler rates in radians/second and items (16-18) are euler accelerations in radians/second squared.

(4) State vector covariance matrix (double precision) (18,18) - The covariance matrix of the above state vector.

(5) CG data (double precision) (3) - The cg position from the nav base in feet x,y,z.

(6) IMU selection (integer) - The selected imu used in the interpolation.

(7) Transformation matrix used (double precision) (3,3) - The transformation matrix used to transform nav body to mean-of-50 coordinates.

(8) Quaternion (double precision) (4) - The interpolated quaternion used at

record time.

24.2.4 Messages

There are no messages sent to the screen, however, the debug formatted file,MERGE66 may have the following error messages sent to it:

(1) "file 5 is not available-merge not produced"

This error message will occur when the file MERGE.IN is not present.

(2) "error on first lear read"

This error message will occur when the file TAPE9 is not present.

(3) "error on second lear read"

This error message will occur when an I/O error occurs on the second read of the TAPE9 file.

(4) "error of first bea read"

This error message will occur when the file BEADATA is not present.

(5) "error on second bea read" or "error on third bea read"

These error messages will occur when an I/O error occurs on the second or third read of the BEADATA file.

(6) "no cg file"

This error message will occur when the file MERGE.IN is not present or the first cg entry is the default number(-9999.d0).

(7) "only one cg position"

This message is a warning message and indicates that only one cgt point was read from the file, MERGE.IN. Suggest rerun of INPUT and rework of the CGTABLE menu item.

(8) "no special events file"

This error message will occur when the file MERGE.IN is not present or the first special event entry is the default number(-9999.d0).

(9) "no special event time after tstart"

This error message will occur when the last time in the special event time array is before the start time of the mission. This indicates some time discrepancy in the special event times.

(10) "error - attempted to propagate lear data beyond legal 5 second excess interval time= xxxxxxx , excess= xxxxxxxxxxxxx"

This warning will occur when a gap occurs in the TAPE9 data longer than five seconds. This warning indicates the intepolation was beyond what was considered a valid interval.

(11) "error - attempted to propagate bea data beyond legal 5 second excess interval time= xxxxxxx , excess= xxxxxxxxxxxxx"

This warning will occur when a gap occurs in the BEADATA data longer than five seconds. This warning indicates the intepolation was beyond what was considered a valid interval.

25.0 METGRAPH

25.1 METGRAPH FUNCTIONAL DESCRIPTION

After the meteorological (MET) data has been read in, this program splits the data into different totems according to latitude and longitude,and outputs key parameters to be plotted. The MET data is also formated for input into OPIP. It also outputs the altitude of the different totems.

25.2 METGRAPH OPERATION DESCRIPTION

25.2.1 Equipment Configuration

The standard Ascent/Descent equipment configuration is required.

25.2.2 Input Items

The input to METGRAPH is the file "met" which contains the meteorological data. The file "met" is the output of the program HPMET.

25.2.2.1 Sample Input

The file "met" is a binary file so no listing is available.

25.2.2.2 Definition of Inputs

A description of met is given in HPMET.

25.2.3 Execution Procedure

The program METGRAPH is normally run from the shell script QAMETGRAPH, however it can be run separately by typing in and executing

metgraph.x

25.2.3.1 Sample Output

METGRAPH creates the file "cmetdata" as well as "toteml", "totem2", totem3", and "totem4". The file "cmetdata" is basically the same as "met". The files "toteml" - "totem4" contain data to be plotted.

25.2.4 Messages

None.

26.0 MSBLS

26.1 MSBLS FUNCTIONAL DESCRIPTION

The function of MSBLS is to incorporate MSBLS (Microwave Scanning Beam Landing System) data into the Descent BET determination.

26.2 MSBLS OPERATIONAL DESCRIPTION

The program MSBLS takes the file "mlsdata" as input and builds the files "tape16", "tape17", and "tape18" containing the MSBLS range, azimuth, and elevation data respectively.

26.2.1 Equipment Configuration

The standard Ascent/Descent equipment configuration is required.

26.2.2 Input Items

The input to MSBLS comes from the files "mlsdata" and "msbls.in".

26.2.2.1 Sample Input

Both input files are binary, so no listing is possible.

26.2.2.2 Definition of Inputs

The file "msbls.in" contains the following

start time
stop time

offset time
drift rate
reference time

The file "mlsdata" contains data with 100 logical records blocked together in each physical record. The first element of each logical record specifies the type of measurement in that record. The fourth element contains a time tag and the seventh element is the measurement itself.

26.2.3 Execution Procedure

In order to run MSBLS, the msbls data tape must first be read in with UN2HP. The user then types in and executes

mslbs.x

26.2.3.1 Sample Output

The output of MSBLS are the files "tape16", "tape17", "tape18" and "msbls66". The file "msbls66" is the only file which is printable and is as follows

```
msbls observations used:   range=   123 azimuth=    79 wedge=    88
```

26.2.4 Messages

None.

27.0 MSLRRESID

27.1 MSLRRESID FUNCTIONAL DESCRIPTION

MSLRRESID computes MSBLS range, azimuth, and elevation residuals from the output of LRBET5. The trajectory generated by LRBET5 is converted into MSBLS range, azimuth, and elavation measurements which are the subtracted from the observed measurements. The output is put in files "lrdifr", "lrdifa", and "lrdife" for range, azimuth and elevation residuals respectively.

27.2 MSLRRESID OPERATIONAL DESCRIPTION

27.2.1 Equipment Configuration

The standard Ascent/Descent Hardware configuration is needed.

27.2.2 Input Items

The inputs to MSLRRESID are the files "tape9", "tape16", "tape17", "tape18", and "mslrresid.in". All input words are double precision.

27.2.2.1 Sample Input

All of the input files are binary, so no listing is available.

27.2.2.2 Definition of Inputs

The file "tape9" is described in the LRBET5 section. The file "tape16" consists of records which contain a time tag and a MSBLS range measurement. The file "tape17" consists of records which contain a wedge time tag and a

MSBLS azimuth measurement. The file "tape18" consists of records which contain a time tag and a MSBLS elevation angle measurement.

The file "mslrresid.in" is described below.

(d double precision)

field	type	description
p	d(540)	the p array described in the LRBET5 section
ps	d(370)	the ps array descibed in the LRBET5 section

27.2.3 Execution Procedure

MSLRRESID is usually called by the shell script QAMSLRRESID, however it can be run separately by typing in and executing

```
mslrresid.x
```

27.2.3.1 Sample Output

The output from MSLRRESID is the files "lrdifr", "lrdifa", and "lrdife" which contain range, azimuth, and elevation residuals respectively. The files are binary but contain the same format of one double precision time tag followed by a double precision measurement residual.

27.3.4 Messages

None.

28.0 MSOBRESID

28.1 MSOBRESID FUNCTIONAL DESCRIPTION

MSOBRESID computes MSBLS range, azimuth, and elevation residuals from the onboard computed trajectory. The onboard conputed trajectory is converted into MSBLS range, azimuth, and elavation measurements which are subtracted from the observed measurements. The output is directed to the files "obdifr", "obdifa", and "obdife" for range, azimuth and elevation residuals respectively.

28.2 MSOBRESID OPERATIONAL DESCRIPTION

28.2.1 Equipment Configuration

The standard Ascent/Descent Hardware configuration is needed.

28.2.2 Input Items

The inputs to MSOBRESID are the files "obdata", "tape16", "tape17", "tape18", and "msobresid.in".

28.2.2.1 Sample Input

All of the input files are binary, so no listing is available.

28.2.2.2 Definition of Inputs

The file "tape16" consists of records which contain a time tag and a MSBLS range measurement. The file "tape17" consists of records which contain a wedge time tag and a MSBLS azimuth measurement. The file "tape18" consists of records which contain a time tag and a MSBLS elevation angle measurement.

The file "obdata" is described below.

name	type	description
intdum	integer	integer value which is thrown away
dummy	double precision	dummy value thrown away
time	double precision	time tag of record
state	double precision	the three elements of position and three elements of velocity

The file "msobresid.in" is described below

(d double precision)

field	type	description
p	d(540)	the p array described in the lrbet5 section
ps	d(370)	the ps array descibed in the lrbet5 section
ndays	d	the number of days since midnight Dec 31

28.2.3 Execution Procedure

MSOBRESID is usually called by the shell script QAMSOBRESID, however it can be run separately by typing in and executing

```
msobresid.x
```

28.2.3.1 Sample Output

The output from MSOBRESID is the files "obdifr", "obdifa", and "obdife" which contain range, azimuth, and elevation residuals respectively. The files are binary but contain the same format of one double precision time tag followed by a double precision measurement residual.

28.3.4 Messages

None.

29.0 OPIP

29.1 OPIP FUNCTIONAL DESCRIPTION

This program is not interactive. The purpose of the program is to generate the final Ascent/Descent output products ready to be copied to tapes. The following specific functions are accomplished by OPIP:

(1) Initialize the input variables from the namelist, OPIP.IN.

(2) Write the initialized variables to the debug file, OPIP66.

(3) Set up the earth, launch, and landing site vectors.

(4) Read the first input record of position, velocity, and attitude, from the file, TRJATTDATA.

(5) Extract the Mean-of-50 data and convert to ECI data.

(6) Calculate the output product times (6 elements)

(7) Calculate gravitational acceleration and add it to sensed acceleration.

(8) Calculate Plumbline coordinate data for ascent trajectories.

(9) Calculate Geographic coordinate data.

(10) Calculate Geodetic coordinate data.

(11) Compute the altitude rates.

(12) Calculate the uncertainties in the data generated so far.

(13) Calculate the slant range to launch point or landing field.

(14) Calculate the Topodetic Nav Base coordinate data.

(15) Calculate the Landing Field coordinate data for descent trajectory.

(16) Calculate Euler angle and Euler angle rates and their uncertainties.

(17) Calculate flight path angle and azimuth and their uncertainties.

(18) Calculate the meteorological data from the CMETDATA file.

(19) Generate the wind relative data for pertinate coordinate frames.

(20) Calculate the aerodynamic parameters for output.

(21) Write the fiche tape file, OPIPFICHE, of the 239 output parameters for this record time.

(22) Write the binary file, BETDATA, of the 239 output parameters for this record time.

(23) Repeat steps (4) to (22) for each time interval on the input tape.

(24) Generate the blocked output tape file, FINALDATA, with a header record.

29.2 OPIP OPERATIONAL DESCRIPTION

OPIP is one of the Ascent/Descent configured programs and resides in /users/Adheaven/EXECUTE. The program requires that MERGE and METGRAPH both have been successully executed generating the files, TRJATTDATA and CMETDATA. The program also requires the final execution of INPUT with all the correct input data inserted so that OPIP.IN will contain the correct inputs. The program generates two primary output files, OPIPFICHE, for the fiche output, and FINALDATA, for the blocked binary output. The program also generates an intermediate file, BETDATA, which is unblocked data without the header data. BETDATA is used for the input to the QA plot program to plot specific output variables. The program also generates a debug print file, OPIP66, which is useful in checking the inputs.

29.2.1 Equipment Configuration

The program must be executed in the directory where the input files are located. The input files are OPIP.IN, TRJATTDATA, and CMETDATA. Output files will be generated in the directory of execution. The standard Ascent/Descent equipment configuration is required.

29.2.2 Input Items

Inputs consist of OPIP.IN, TRJATTDATA, and CMETDATA.

29.2.2.1 Sample Input

All of the input files are binary.

29.2.2.2 Definition of Inputs

OPIP.IN

OPIP.IN is a binary file and is used as an input file for OPIP. It contains nine records of the following elements, each of the size indicated:

(1) Record 1 contains 31 elements defined as follows:

- (a) Geographic latitude (double precision) - The astronomic latitude of the launch point in degrees.

- (b) Astronomic longitude (double precision) - The astronomic longitude of the launch point in degrees.

(c) Mean Sea Level (msl) altitude (double precision) - The astronomic msl altitude of the launch point in feet.

(d) Launch azimuth (double precision) - The launch azimuth in degrees.

(e) Geodetic height (double precision) - The geodetic height as measured in feet from the Fisher ellipsoid to the launch point.

(f) Geodetic latitude (double precision) - The geodetic latitude of the launch point in degrees.

(g) Geodetic longitude (double precision) - The geodetic longitude of the launch point in degrees.

(h) Ascent flag (logical) - logical flag to indicate ascent(True) or descent(False).

(i) Mean Sea Level (msl) altitude (double precision) - The astronomic msl altitude of the runway in feet.

(j) Geographic latitude (double precision) - The geographic latitude of the runway in degrees.

(k) Geographic longitude (double precision) - The geographic longitude of the runway in degrees.

(l) Runway azimuth (double precision) - The runway azimuth in degrees.

(m) Debug flag (logical) - logical flag to turn on (True) or turn off (False) the OPIP debug print mode.

(n) Delta time (double precision) - The difference in time expressed in seconds between the onboard clock and the ground clock.

(o) Geodetic height (double precision) - The geodetic height as measured in feet from the Fisher ellipsoid to the runway.

(p) Geodetic latitude (double precision) - The geodetic latitude of the runway in degrees.

(q) Geodetic longitude (double precision) - The geodetic longitude of the runway in degrees.

(r) Equitorial radius (double precision) - The equitorial radius of the earth measured in feet.

(s) GMT day (integer) - The day of ignition of the SRBs in days since midnight Dec 31.

(t) GMT seconds (double precision) - The seconds from midnight day of launch to SRB ignition corrected for time biases.

(u) GMT year (integer) - The year of SRB ignition (four digits).

(v) Mean of 50 to ECI transformation matrix (double precision) - The mean of 50 coordinates to ECI coordinates transformation matrix values in column major order.

(w) CG variances (double precision) (3) - The variances in the CG locations measured in feet.

(x) Polar radius (double precision) - The polar radius of the earth measured in feet.

(y) SRB day (integer) - The day of ignition of the SRBs in days since midnight Dec 31. (Jan 1 = day 1)

(z) SRB seconds (double precision) - The seconds from midnight day of launch to SRB ignition.

(aa) SRB year (integer) - The year of SRB ignition (four digits).

(ab) Drftrt (double precision) - the clock drift rate of the onboard clock (normally zero) measured in seconds per second.

(ac) Epoch day (integer) - The day of RNP epoch (SRB ignition) in days since midnight Dec 31. (Jan 1 = day 1)

(ac) Epoch year (integer) - The year of RNP epoch (SRB ignition)(four digits).

(ad) Omega (double precision) - The earth rotation rate measured in radians per second.

(2) Record 2 through 9 consist of the header information for the final delivery tape file. Each record is 80 characters long.

TRJATTDATA

TRJATTDATA is a primary input file to OPIP. It contains the input trajectory data. It is composed of multiple identical records of the following form and order:

(1) Special event pointer (integer) - Pointer to the special event time which this record represents(i.e., 0 = normal output time; integer number = index of the special event array).

(2) Time (double precision) - time of the record in seconds from midnight day of launch.

(3) State vector (double precision) (18) - The state vector at the time of the record. Data is in Mean of 50 coordinates system. Items (1-3) are position (x,y,z) in feet; items (4-6) are velocity ($\dot{x}$,$\dot{y}$,$\dot{z}$) in feet/second; items (7-9) are sensed acceleration in feet/second squared; items (10-12) are Euler angles in radians; items (13-15) are Euler rates

in radians/second and items (16-18) are Euler accelerations in radians/second squared.

(4) State vector covariance matrix (double precision) (18,18) - The covariance matrix of the above state vector.

(5) CG data (double precision) (3) - The CG position from the nav base in feet x,y,z.

(6) IMU selection (integer) - The selected IMU used in the interpolation.

(7) Transformation matrix used (double precision) (3,3) - The transformation matrix used to transform nav body to mean of 50 coordinates.

(8) Quaternion (double precision) (4) - The interpolated quaternion used at the record time.

CMETDATA

CMETDATA is the file of meteorological data for the columns of air (totums) used by OPIP to determine the various meteorological parameters for the output products. For ascent there is only one totum located close to the launch point. For descent, there can be as many as necessary, usually between two and four. The data is in multiple identical records. Different totums are indicated by a difference in latitude and longitude. The record format is as follows:

(1) Latitude (double precision) - The geodetic latitude of the totum in degrees (North is +).

(2) Longitude (double precision) - The geodetic longitude of the totum in degrees (East is + and max is 360 degrees).

(3) Spare, not used (double precision).

(4) Spare, not used (double precision).

(5) Geodetic altitude (double precision) - The geodetic altitude of the datum point within the totum where the meteorological parameters are valid. The altitude is measured in feet.

(6) Horizontal wind speed (double precision) - The horizontal wind speed in feet per second at the altitude datum point in the totum.

(7) Horizontal wind direction (double precision) - The horizontal wind direction in degrees from North at the altitude datum point in the totum.

(8) Temperature (double precision) - The ambient temperature in degrees Rankin at the altitude (5) in the totum.

(9) Pressure (double precision) - The ambient pressure in millibars at the altitude (5) in the totum.

(10) Density (double precision) - The ambient density in slugs/ft cubed at the altitude (5) in the totum.

(11) Dewpoint (double precision) - The dewpoint temperature in degrees Rankin at the altitude datum point in the totum.

(12) Temperature uncertainty (double precision) - The temperature systematic uncertainty in degrees Rankin at the altitude datum point in the totum.

(13) Pressure uncertainty (double precision) - The pressure systematic uncertainty in millibars at the altitude datum point in the totum.

(14) Density uncertainty (double precision) - The density systematic uncertainty in slugs/ft cubed at the altitude datum point in the totum.

(15) Horizontal wind speed uncertainty (double precision) - The horizontal wind speed systematic uncertainty in feet/second at the altitude datum point in the totum.

(16) Horizontal wind speed noise (double precision) - The horizontal wind speed noise in feet/second at the altitude datum point in the totum.

(17) Vertical wind speed noise (double precision) - The vertical wind speed noise in feet/second at the altitude datum point in the totum.

(18) Horizontal wind direction uncertainty (double precision) - The horizontal wind direction systematic uncertainty in degrees at the altitude datum point in the totum.

(19) Horizontal wind speed noise (double precision) - The horizontal wind speed noise in degrees at the altitude datum point in the totum.

(20) Spare, not used (double precision)

29.2.3 Execution Procedure

Normal setup of the production directory will copy the current version of the executable OPIP program. Execution is accomplished by typing in and executing

```
opip.x
```

Runtime varies depending on the trajectory type; ascent runs require approximately 80 minutes, and descent runs require approximately 100 minutes

29.2.3.1 Sample Output

Output consists of the files OPIPFICHE, BETDATA, OPIP66, and the main program output, FINALDATA.

29.2.3.1.1 OPIPFICHE

The following is a one page (132 character) sample of the OPIPFICHE file:
(shown with wrap around to accommodate 132 characters per line)

```
 opip version of may 21, 1986 has started on 86/ 8/22  at 02:06:29
 descmet version of may. 16, 1981
 eulang version of may 26, 1983
 constants built into aerodyn version of feb. 6, 1981
   gacc =    .321740000000D+02  keas =    .121527000000D+02  kmach =
.428905000000D+04

  1  get: 521960.0000  gmt: date  18/1986  12:54:20.0000  sgmt: day  18
12:54:20.0000  set: 0  pimu 4  time: 564860.0000
                 x          y          z          xd         yd         zd        xdd
    ydd      zdd
  2  m50nb       19182097   -2287947 -10503956   3530.04  25054.96   1043.56
.00      .00      .00   rm 21989103.44
  3  m50cg       19182104   -2287902 -10503923   3530.02  25054.98   1043.54
.01      .00      .00   vm     25323.93
   4  gtofdnb    14280558   13063434 -10437097 -15722.87  17987.94   1056.36
.00      .00      .00   gm          -.06
  5  gtofdnb wind rel vel + total acc       -15722.87  17987.94   1056.36  -16.
05  -14.79   13.86    pm       87.34
  6  gtofdnb grav acc                                                       -18.
90  -17.29   13.86
  7  gtofdcg     14280558   13063434 -10437097 -15722.87  17987.94   1056.36
.00      .00      .00
  8  gtofdcg wind rel vel                    -15722.87  17987.94   1056.36
  9  runway     -6563690   -1783877   41821553  15933.70  16640.90   6410.01
.00      .00      .00
 10  topdetic                                  1186.06  23884.78     29.20
.00      .00      .00   vtd  23914.25
 11  topdetic velu + accu                          .25       .37      1.65
.00      .00      .00   gtd      -.070
 12  topdetic wind rel vel                     1186.06  23884.78     29.20
```

ptd 87.157
13 bodynb -19458.65 11939.30 7120.73
.00 .00 .00 vtdu .37
14 bodynb velu + accu 24.09 35.89 39.57
.00 .00 .00 gtdu .000
15 bodynb wind vector .00 .00 .00
ptdu .000
16 bodynb wind vectoru .00 .00 .00
17 bodynb wind rel vel -19458.65 11939.30 7120.73
18 bodynb wind rel velu 24.09 35.89 39.57

25 lat -28.489595 lon 42.451356 h 1079223 hd -29.20 delta
-28.336474
26 rs 42371058 s 59136996 hu 404 hdu 1.65

1 quaternion direction cosines pitch
yaw roll
27 q1 .54815342 -.06049238 -.78694542 -.61405015 euler 158.375 2
8.965 8.403
28 q2 .41143851 -.36984357 .58906148 -.71848613 euleru .113
.099 .113
29 q3 -.70289300 .92712265 .18363956 -.32668043 eulerd .059
-.038 .022
30 q4 .19023044 eulerdu .113
.099 .113

31 alpha 159.900 q .102E-01 eas 1.7 visc .900E+0
0 temp 612.3
32 alphau .115 qu .797E-03 easu .1 viscu .364E+0
0 tempu 142.2
33 betap 148.468 qalpha .163E+01 mach 19.799 l .000
3 press .412E-04
34 betapu .104 qbeta .306E+00 machu 2.299 d/m -.000
3 pressu .733E-05
35 bank 115.451 lod -23.255
1 dens .357E-10

36 beta 29.951

37 betau .099

yaw pitch

roll

38 topodetic euler angles -123.570 18.895

177.670

39 topodetic euler angle rates -.042 -.047

.075

x y

z

40 inertial body angular rates .022 -.008

-.034

41 inertial body angular rate uncertainties .099 .099

.099

42 inertial body angular accelerations -.026 .008

.005

43 inertial body angular acceleration uncertainties .099 .099

.099

44 center of mass contact accelerations -body coordinates .001 -.003

.008

45 center of mass contact acceleration uncertainties .007 .097

.097

46 center of mass in body axis coordinates -56.084 .033

3.892

OPIP66

OPIP66 is a debug file.

The following is a sample of the debug file, OPIP66:

```
 opip version of may 21, 1986 has started on 86/ 8/22  at 02:06:29
  $opip.in
  aalat =   .0000000000000000D+00
  aalong =   .0000000000000000D+00
  aamslh =   .0000000000000000D+00
  aazimu =   .9000000000000000D+02
  agh =   .0000000000000000D+00
  aglat =   .2860842155882358D+02
  aglong =   .2793959094885685D+03
  ascent =      F
  damslh =   .2281000000000000D+04
  dalat =   .3491628003000000D+02
  dalong =  -.1178624183600000D+03
  dazimu =   .2382411629700000D+03
  debug =      F
  deltte =   .0000000000000000D+00
  dgh =   .2096580000000000D+04
  dglat =   .3491628003000000D+02
  dglong =  -.1178624183600000D+03
  eqrad =   .2092574146981627D+08
  gmtcond =          12
  gmtcons =   .0000000000000000D+00
  gmtcony =        1986
  m502eci(1,1) =  -.3540152012516661D+00
  m502eci(2,1) =  -.9352331767471923D+00
  m502eci(3,1) =   .3484593820901000D-02
  m502eci(1,2) =   .9352388795881591D+00
  m502eci(2,2) =  -.3540172844595411D+00
  m502eci(3,2) =   .2026269846312058D-04
  m502eci(1,3) =   .1214656094066681D-02
```

```
 m502eci(2,3) =   .3266100924153619D-02
 m502eci(3,3) =   .9999939285792321D+00
 partr(1) =   .1000000000000000D+01
 partr(2) =   .1000000000000000D+01
 partr(3) =   .1000000000000000D+01
 polrad =   .2085559148165061D+08
 srbigd =          12
 srbigs =   .4290000000000000D+05
 srbigy =        1986
 tddrift =   .0000000000000000D+00
 tepochd =          12
 tepochy =        1986
 w =   .7292115146459201D-04
 $end
descmet version of may. 16, 1981
 .2100D+02  .1639D+03  .1000D+01  .6400D+02
 .3490D+02  .2422D+03  .6500D+02  .1000D+03
eulang version of may 26, 1983
opip has ended.
finaldata output of 1 jul 1986 has started.
FLT 61C
1986      12
DESCENT BET OUTPUT PRODUCTS
START TIME      564860.0000
STOP  TIME      568800.0000
DATA RATE 1 PER SECOND
COMMENTS
LAUNCHED 09 JAN 1986
```

29.2.3.2 Definition of Outputs

BETDATA

BETDATA is an intermediate output of OPIP. It is used as the input of the QA routine, QAOPIP. Each record has 239 double precision numbers. See Appendix A for the definition of each double precision word.

FINALDATA

FINALDATA is the primary binary output of OPIP. It contains a header record composed of ten 80 character words in ASCII format. After the header record, the file contains blocked records, each block consisting of four of the BETDATA records. Data in the BETDATA records are defined in Appendix A.

29.2.4 Messages

There are no messages sent to the display. However, several error or warning messages may be sent to the print file. These error or warning messages are as follows:

(1) "fatal error --- premature end of file
on input file from merge"

This error message will occur if the TRJATTDATA file has only one record. OPIP will abort with this message. Check the inputs to MERGE and rerun MERGE.

(2) "xxx errors for timout yyyyyyy

This error message will occur when warning messages (3) and/or (4) also appear. For each warning message that occurs a count is reported in this error message (xxx). The time of the record being processed will be recorded (yyyyyy). The problem is not major since the warnings are for negative variances in Euler angle or angle rates. The routine that generates these errors is for elements 148 to 159 in the output which are not normally used. The true topodetic Euler angles and rates are elements 213 to 218 and are not generated in the eulang subroutine.

(3) "rate variance xx in eulang is yyyyyy "

This warning message will occur when a negative rate variance (yyyyyy) is detected in the xx element of the section of the EULANG subroutine that calculates the rate variances. The routine then substitutes a zero for the variance and continues.

(4) "angle variance xx in eulang is yyyyyy "

This warning message will occur when a negative angle variance (yyyyyy) is detected in the xx element of the section of the EULANG subroutine that calculates the angle variances. The routine then substitutes a zero for the variance and continues.

(5) "error --- no met data for ascent"

This error will occur when the ascent CMETDATA file only has one altitude entry in it. A new meteorological tape is needed.

30.0 QA

30.1 QA FUNCTIONAL DESCRIPTION

QA is an interactive program which plots data on the users terminal. The program reads a user specified file and plots two user determined fields within each record in the file. The plot is automatically scaled to fit the data. There is a label printed on the top of the graph. Some of the quality assurance shell scripts call QA.

30.2 QA OPERATIONAL DESCRIPTION

When QA is used as a stand alone routine, the program will prompt the user for the name of the file which will furnish the items to be plotted.

30.2.1 Equipment Configuration

QA uses the standard Ascent/Descent hardware configuration.

30.2.2 Input Items

QA has both interactive and binary file input. The interactive input is described here. The binary file is assumed to be a sequential file and all fields within the records contain double precision data.

30.2.2.1 Sample Input

```
1
x position vs time
tape9
2
```

1
2
0
0
0

30.2.2.2 Definition of Inputs

The first prompt by QA is

"Please, select the Desired OPTION
0 = EXIT 1 = Graph 2 = GRAPH WITH HEADER"

If the user enters "0" then the program stops.
If the user enters "1" then the next prompt is

"PLEASE ENTER THE PLOT TITLE"

THe user enters the title. The next prompt is

"PLEASE, ENTER THE DATA FILE NAME"

After entering a valid file name, the next prompt is

"Please, Enter the RECORD SIZE"

This is the number of double precision words in the record

"ENTER THE CODE FOR X_AXIS VARIABLE"

This is the field number in the record of the x-axis variable. The next prompt is

"ENTER THE CODE FOR Y_AXIS VARIABLE"

This is the field number in the record of the y-axis variable. The next prompt is

"input number of records to skip"

The program skips the first n records where n is the number just entered. This is used to skip past header records. The next prompt is

"input x axis bias"

This number is then added to the x axis variable. The next prompt is

"0 = PLOT ALL   1 = PLOT SUBSETS"

If a "0" is entered, QA then draws the plots. If a "1" is entered, the following prompt is given

"0 = min   1000 = max
enter minimum and maximum x values"

The user enters the minimum x axis value and maximum x axis value to print. The data is rescaled to the new minimums and maximums. When the plot is finished, the prompt is

"another plot (y/n)"

If the user enters a "y" or "Y", the user is returned to the prompt

"0 = PLOT ALL   1 = PLOT SUBSET"

If the user enters a "n" or "N", the user is returned to the first prompt

30.2.3 Execution Procedure

To run the program the user must type in and execute

30.2.3.1 Sample Output

The output is a plot.

30.2.4 Messages

None.

31.0 QALRRESID

31.1 QALRRESID FUNCTIONAL DESCRIPTION

QALRRESID plots the files "residu1" - "residu20". Where each file contains radar range, azimuth, and elevation residuals for a given radar station. All range plots are scaled the same as are all azimuth and elevation plots.

31.2 QALRRESID OPERATIONAL DESCRIPTION

31.2.1 Equipment Configuration

The standard Ascent/Descent Hardware configuration is needed to run QALRRESID.

31.2.2 Input Items

The input to QALRRESID are the binary files "residu1" - "residu20".

The files "residu1" - "residu20" contain data records, each of which consists of 7 double precision words in the following order:

station id
time
range residual
azimuth residual
elevation residual
distance residual
doppler residual

31.2.3 Execution Procedure

In order to run QALRRESID, the program LRRESID must be run first. The user must type in and execute

```
qalrresid.x
```

31.2.3.1 Sample Output

The output is four plots, one plot for the range, azimuth, elevation, and doppler residuals.

31.3.4 Messages

None

32.0 QARESID

32.1 QARESID FUNCTIONAL DESCRIPTION

QARESID plots the files "differl" - "differ20". Where each file contains radar range, azimuth, and elevation residuals for a given radar station. All range plots are scaled the same as are all azimuth and elevation plots.

32.2 QARESID OPERATIONAL DESCRIPTION

32.2.1 Equipment Configuration

The standard Ascent/Descent Hardware configuration is needed to run QARESID.

32.2.2 Input Items

The input to QARESID is the output from RAECOMP.

The files "differl" - "differ20" are binary files. Each file consists of data records which contain 7 double precision words in the order:

station id
time
range residual
azimuth residual
elevation residual
distance residual
doppler residual

32.2.3 Execution Procedure

Before running QARESID, the program RAECOMP must be run. The user then types in and executes

```
qaresid.x
```

32.2.4 Messages

None.

33.0 QUATQA

33.1 QUATQA FUNCTIONAL DESCRIPTION

QUATQA is a program which uses the Best Estimate of Attitude (BEA) quaternion to compute the angular distance between two quaternions, and the angular rate. This information is stored along with the time tag and the time difference in the file "rotations".

33.2 QUATQA OPERATIONAL DESCRIPTION

33.2.1 Equipment Configuration

The standard Ascent/Descent hardware is used in quatqa.

33.2.2 Input Items

QUATQA reads the binary file "beadata".

33.2.2.1 Sample Input

33.2.2.2 Definition of Inputs

The file "beadata" is as follows

item	type	contents
time	double precision	quaternion time tag
option	integer	option used to select BEA quaternion
status	integer	how BEA quaternion was selected
q	double precision	the BEA quaternion

33.2.3 Execution Procedure

QUATQA is normally called by the shell script QAQUAT, however it can be executed separately by typing in and executing

```
quatqa.x
```

33.2.3.1 Sample Output

The output of QUATQA is the file "rotations" which is binary. A descrition of "rotations" is as follows

item	type	contents
time	double precision	quaternion time tag
delta time	double precision	time difference
rot angle	double precision	the rotation between quaternions in degrees
rot rate	double precision	the rotation rate in degrees

33.2.4 Messages

None

34.0 RADAR5

34.1 RADAR5 FUNCTIONAL DESCRIPTION

This program is not interactive and is only executed after manually selecting the radar station to be used in the filter. The program does the basic setup of radar input files for the filter. It generates the radar input files (TAPE11, TAPE12, TAPE13, and TAPE14) based on the manual selection entered into INPUT. The basic functions are:

(1) Build four tables with start/stop times for each of the output files.

(2) Check the tables for consistancy.

(3) Unblock and separates the RDRDATA file into individual intermediate radar files (RDRFILE(i)).

(4) Convert ranges from feet to meters.

(5) Convert X/Y keyhole data into azimuth/elevation data for s-band stations.

(6) Read the intermediate RDRFILE(i) and loads the TAPE(i) files.

34.2 RADAR5 OPERATIONAL DESCRIPTION

The executable configured code is in

/users/Adheaven/EXECUTE.

A normal setup of the flight production directory will move a copy of the executable code to the production directory. For execution, the file, RDRDATA and RADAR5.IN must be in the directory. The primary output files are TAPE11, TAPE12, TAPE13 and TAPE14. The quality assurance output file is RADAR66. RADAR66 is a formatted file and is used for quick analysis of the results of the program. Intermediate data files, RDRFILE(i), are generated as a result of the process but deleted after use by the program.

34.2.1 Equipment Configuration

The program must be executed in the directory where the input files are located. The input files are RDRDATA and RADAR5.IN. Output files will be generated in the directory where execution occurs. The standard Ascent/Descent equipment configuration is required.

34.2.2 Input Items

Input consists of the two files: RADAR.5 and RDRDATA.

RADAR5.IN

The file RADAR5.IN is a binary file generated from successful execution of the INPUT program. Data in the RADSELECT menu item in INPUT must have been updated based on the chosen radar selections otherwise default radar selection data will be inserted.

RDRDATA

The file RDRDATA is a binary file generated from a UN2HP execution using the raw radar tape as an input.

34.2.2.1 Definition of Inputs

RADAR5.IN

RADAR5.IN is one of the menu driven outputs of INPUT consisting of two double precision numbers, the four radar selection arrays, and the ID array. The file is binary and contains the following elements:

(1) start time (double precision) - the start time of the mission in seconds from midnight day of launch,

(2) stop time (double precision) - the stop time of the mission in seconds from midnight day of launch,

(3) cband1 (double precision) - an array containing the file ID, start time, and stop time for each interval selected to be used in the primary radar (i.e., radar data consisting of range, azimuth, and elevation). A capability exists for ten station intervals.

(4) cband2 (double precision) (3x10) - an array containing the file ID, start time, and stop time for each interval selected to be used in the secondary radar (i.e., range data only). A capability exists for ten station intervals.

(5) cband3 (double precision) (3x10) - an array containing the file ID, start time, and stop time for each interval selected to be used in the secondary radar (i.e., radar data consisting of only range). A capability exists for ten station intervals.

(6) sband (double precision) (3x10) - an array containing the file ID, start time, and stop time for each interval selected to be used in the s-band radar (i.e., has range and Doppler data). A capability exists for ten station intervals.

(7) station ID (integer) (60) - Lear radar station ID's are presented in the order of the TRWID radar station ID's (i.e., Lear ID 13 for Goldstone radar is the 6th integer value since the TRWID is 6 for the same station). There are 54 stations used allowing 6 expansion slots.

RDRDATA

RDRDATA is a file of blocked identical numerical records with one header record. The blocking factor is 125 numerical records. The header record is 81 characters and is not used for any purpose. Each new radar station will begin a new block. When data ends on a radar station before a block ends, the rest of the block is filled with -9999.d0 for every word in the record. Each record has the following data in the order listed:

(1) record count (double precision) - the record number in the block (1-125)

(2) station ID number (double precision) - the TRWID number of the radar station. Numbers under 100 are high rate (tenth second data) stations. Stations over 100 are low rate stations and are normally S-band stations. It is possible to get high rate and low rate data from the same station on this file. If this occurs the high rate data will be processed.

(3) time (double precision) - the time tag of the data on the record. The data is time taged in seconds from midnight the day of launch.

(4) range (double precision) - the range measurement for that time interval. Data is measured in feet.

(5) elevation or X angle (double precision) - this measurement is an angle measurement. Elevation is measured on all C-band stations; X angle of the keyhole measurement for all S-band stations. Measurements are in radians.

(6) azimuth or Y angle (double precision) - this measurement is an angle measurement. Azimuth is measured on all C-band stations; Y angle of the keyhole measurement for all S-band stations. Measurements are in radians.

(7) Doppler counts (double precision) - this measurement is the Doppler counts for the S-band stations; it has no value for a C-band station. The measurement is dimensionless.

(8) station frequency (double precision) - this measurement contains the frequency of the S-band stations and is undefined for the C-band stations. The data is not used.

34.2.3 Execution Procedure

Normal setup of a production directory will copy the current version of RADAR5 into the production directory. Execution is accomplished by entering

```
radar5.x
```

Run time is approximately three minutes.

34.2.3.1 Sample Output

34.2.3.1.1 RADAR66

The following is a condensed form of the formatted file RADAR66:

radar version 2.000

j	station	start	stop	slot
1	cnoc	42906.10	42948.10	1
2	cnvc	42948.11	43025.10	1
3	cnmc	43025.11	43042.10	1
4	gbic	43042.11	43332.10	1
5	bdqc	43332.11	43578.10	1
6	cnmc	42910.10	42926.10	2
7	patc	42937.11	43298.10	2
8	bdqc	43298.10	43332.10	2
9	gbic	43332.11	43372.10	2
10	mlac	42929.10	42957.10	3
11	cnmc	42957.11	43075.10	3

12	mlac	43075.11	43272.10	3
13	mils	42912.10	43214.10	4
14	bdas	43272.10	43560.10	4

radar seperation information

TRWID	LRID	SLOT	START	STOP
49	43	1	42906.100	42948.100
21	8	1	42948.110	43025.100
48	38	1	43025.110	43042.100
25	12	1	43042.110	43332.100
20	2	1	43332.110	43578.100
48	38	2	42910.100	42926.100
32	22	2	42937.110	43298.100
20	2	2	43298.100	43332.100
25	12	2	43332.110	43372.100
30	21	3	42929.100	42957.100
48	38	3	42957.110	43075.100
30	21	3	43075.110	43272.100
12	20	4	42912.100	43214.100
3	3	4	43272.100	43560.100

rdrsep output data

input to rdrsep

j	trwid	lrid	slot(j)	start	stop
1	49	43	1	42906.100	42948.100
2	21	8	1	42948.110	43025.100
3	48	38	1	43025.110	43042.100
4	25	12	1	43042.110	43332.100
5	20	2	1	43332.110	43578.100
6	48	38	2	42910.100	42926.100
7	32	22	2	42937.110	43298.100
8	20	2	2	43298.100	43332.100
9	25	12	2	43332.110	43372.100
10	30	21	3	42929.100	42957.100
11	48	38	3	42957.110	43075.100
12	30	21	3	43075.110	43272.100
13	12	20	4	42912.100	43214.100
14	3	3	4	43272.100	43560.100

```
j     trwid lrid  slot(j)   start          stop
 1      49     43       1       42906.100      42948.100     322
 2      21      8       1       42948.110      43025.100     624
 3      48     38       1       43025.110      43042.100       0
 4      25     12       1       43042.110      43332.100    2691
 5      20      2       1       43332.110      43578.100    2449
 6      48     38       2       42910.100      42926.100     150
 7      32     22       2       42937.110      43298.100    1792
 8      20      2       2       43298.100      43332.100     331
 9      25     12       2       43332.110      43372.100     399
10      30     21       3       42929.100      42957.100     107
11      48     38       3       42957.110      43075.100     744
12      30     21       3       43075.110      43272.100     899
13      12     20       4       42912.100      43214.100    1980
14       3      3       4       43272.100      43560.100    2879
 bldrdr- build radar for lrbet5
   getrdr input data
     slot =  1
     slot =  1
     slot =  1
     slot =  1
     slot =  1
     slot =  2
     slot =  2
     slot =  2
     slot =  2
     slot =  3
     slot =  3
     slot =  3
     slot =  4
     slot =  4
cbptr(1)=  1 cbptr(2)=  6 cbptr(3)= 10 sbptr=  13
 observations used for the lear input file
cb1=  6086 cb2=  2672 cb3=  1750 sb=  4859
 6704 records contain some new radar data
finished radar build
```

34.2.3.2 Definition of Outputs

TAPE11,TAPE12,TAPE13

These three files are output files generated in the RADAR5 process and represent the C-band radar inputs to the filter (LRBET5). The records contain the following elements as ordered:

(1) time (double precision) - time in seconds measured from midnight day of launch.

(2) station ID (integer) - the radar station TRWID as collected from the raw data file.

(3) C-band range (double precision) - the range measurement in meters as measured at time (1).

(4) C-band azimuth (double precision) - the azimuth measurement in radians as measured at time (1).

(5) C-band elevation (double precision) - the elevation measurement in radians as measured at time (1).

TAPE14

TAPE14 is an output file similar to TAPE11, TAPE12, and TAPE13 and generated in the RADAR5 process. This file represents the final S-band radar inputs to the filter (LRBET5). The records contain the following elements as ordered:

(1) time (double precision) - time in seconds measured from midnight day of launch.

(2) station ID (integer) - the radar station TRWID as collected from the data file.

(3) S-band range (double precision) - the range measurement in meters as measured at time (1).

(4) S-band doppler counts (double precision) - the doppler counts in frequency shift in cycles/sec as measured at time (1).

34.2.4 Messages to the RADAR66 file

"** error** start time exceeds stop time"

This error message occurs when a station stop time is before the start time of that entry.

"**error ** station start time is less than master start time"

This message occurs when the mission start time is after a radar start time.

"**error** station stop time exceeds master stop time"

This message occurs when the mission stop time is before a radar stop time.

"**error** lrid(j) is out of range"

This message occurs when the lear id is negative ie., out of range.

"**error** station starts before previous station stops"

This message occurs when two radar stations have overlapping times for the same file.

"** wrong type was given for radar with trwid = xxxx
radar output file empty"

This message occurs when a c-band station was put into the s-band array or vice versa.

"end of file encountered while reading radar data"

This message occurs when an I/O error is encountered on the read of the radar input file before all the stations have been separated.

35.0 RADSELECT

35.1 RADSELECT FUNCTIONAL DESCRIPTION

RADSELECT is a configured program and is included in the shell script AUTOSELECT. The progam accepts radar data from the CB/SB files, evaluates the data in each ten second interval, and selects the radar data to assign to TAPE11, TAPE12, TAPE13, and TAPE14. The functions performed by the program are as follows:

(1) Read the namelist file RADSELECT.IN and initializes the correct data files.

(2) Calculate the radar to OBDATA/TAPE9 trajectory differences for each radar file.

(3) Calculate the statistical data on the differences for each ten second data block.

(4) Edit the bad data blocks based on criteria established for the type of base data comparison used (onboard data or filter data).

(5) Summarize the block data, output the summary to a print file.

(6) Select the "best" data blocks and build the TAPE11, TAPE12, TAPE13, and TAPE14 output files.

35.2 RADSELECT OPERATIONAL DESCRIPTION

The executable configured code is in /users/Adheaven/EXECUTE. A normal setup of the flight production directory will move a copy of the executable code into the flight directory. For individual execution (outside of shell script AUTOSELECT operations), the following files must be in the directory: RADSELECT.IN, CB[1-4], and SB[1-2], and either TAPE9 or OBDATA. The primary output files are TAPE11, TAPE12, TAPE13, and TAPE14. Quality assurance output files are DIF(i), PLTDIF(i), AVE(i) and RADS66. RADS66 in a formatted file for quick analysis of the program output. PLTDIF(i) files are QA files designed for the plot routine QAPLOTDIFF. DIF(i) files are the unmodified differances file and represent full unchopped versions of the PLTDIF(i) file. AVE (i) files are intermediate files useful for malfunction analysis and traceback information.

35.2.1 Equipment Configuration

The standard Ascent/Descent equipment configuration is needed.

35.2.2 Input Items

The following files are necessary inputs for execution: RADSELECT.IN, CB[1-4], SB[1-2] and either TAPE9 or OBDATA.

RADSELECT.IN

RADSELECT.IN is a namelist file consisting of single value variables and array variables. The file is binary and the elements are as follows: day of launch from midnight December 31 (1 integer value), mission start time (1 double precision variable), mission stop time (1 double precision variable), station id array (60 integer variables), the P array with 540 double precision variables, the PS array with 372 double precision variables, and the X array of initial state with 20 double precision variables.

CB[1-4]/SB[1-2]

CB[1-4]/SB[1-2] are sequential binary input radar files and contain the radar range, azimuth, elevation and doppler data for each time interval where data is available.

TAPE9

TAPE9 is a sequential binary output file of LRBET5 and contains the filter trajectory state (time, position, and velocity, etc.) values.

OBDATA

OBDATA is a sequential binary file of onboard state (time, position, and velocity) values.

35.2.2.2 Definition of Inputs

RADSELECT.IN

RADSELECT.IN is a namelist file containing NDAYS, START, STOP, ID, P, PS, and X. The order and size of the file is as follows:

(1) day of launch (integer) - the day of launch measured from midnight December 31.

(2) start time (double precision) - time in seconds of the start of the mission based on midnight day of launch,

(3) stop time (double precision) - time in seconds of the stop of the mission based on midnight day of launch,

(4) station ID (integer) (60) - lear radar station ID's are presented in the order of the TRWID radar station ID's (i.e., Lear ID 13 for the Goldstone radar in California is the 6th integer value since the TRWID is 6 for the same station). There are 54 stations used, allowing 6 expansion slots.

(5) P (double precision) (540) - this array contains all the LRBET5 common variables.

(6) PS (double precision) (372) - this array contains all the radar station position information.

(7) X (double precision) (20) - this array contains the initial state vector of values for LRBET5.

CB[1-4]/SB[1-2]

These files contain the radar data from different stations merged together to form continuous tracking data. When only one radar station is available, then the lowest numbered file is selected to contain data. S-band data is on SB1 and SB2; C-band data is on CB1, CB2, CB3, and CB4 in that order. All the files are not necessary for operation of the program. Usually CB1, CB2 and SB1 will be large files with CB3 having little data in it. CB4 and SB2 are overflow files and normally not used. The files consist of multiple identical records of the following data items:

(1) station ID number (double precision) - the TRWID number of the radar station. Numbers under 100 are high rate(tenth second data) stations. Stations over 100 are low rate stations and are normally S-band stations.

(2) time (double precision) - the time tag of the data on the record. The data is time taged in seconds from midnight the day of launch.

(3) azimuth (double precision) - this measurement is an azimuth angle measurement. Measurements are in radians.

(4) elevation (double precision) - this measurement is an elevation angle measurement. Measurements are in radians.

(5) range (double precision) - the range measurement for that time interval. Data is measured in meters.

(6) doppler counts (double precision) - this measurement is the doppler counts for the S-band stations; it has no value for a C-band station. The measurement is dimensionless.

TAPE9

TAPE9 is a primary input to the RADSELECT process. TAPE9 is calculated using the radar selection based on the previous running of the LRBET5 filter process. This file contains the LRBET5 output products consisting of identical records with the ordered elements as defined below:

(1) time (double precision) - this is the time of the state vector measured in seconds from midnight of the day of launch.

(2) state vector (20) (double precision) - this is an array of the filter calculated state vector with (1-3) position components.(X,Y,Z) in mean of 50 coordinates measured in meters; (4-6) velocity components ($\dot{X},\dot{Y},\dot{Z}$) in mean of 50 coordinates measured in meters/second; (7-9) imu misalignment of the X,Y,Z components in mean of 50 coordinates measured in radians; (10) C-band1 range bias measured in meters; (11) C-band1 azimuth bias measured in radians; (12) C-band1 elevation bias measured in radians; (13) C-band2 range bias measured in meters; (14) C-band3 range bias measured in meters; (15) S-band range bias measured in meters; (16) S-band Doppler integration constant measured in meters; (17) S-band Doppler integration constant measured in cycles; (18) MSBLS range bias measured in meters; (19) MSBLS azimuth bias measured in radians; (20) MSBLS wedge angle bias measured in radians.

(3) sensed acceleration (3) (double precision) - the sensed acceleration components ($\ddot{X},\ddot{Y},\ddot{Z}$) as calculated by the filter in mean of 50 coordinates and measured in meters per second squared.

(4) covariance matrix (20x20) (double precision) - the state vector covariance matrix as defined by (2) above.

(5) total acceleration (3) (double precision) - the totaled acceleration components ($\ddot{X}$,$\ddot{Y}$,$\ddot{Z}$) as calculated by the filter and modified by gravity in Mean of 50 coordinates and measured in meters per second squared.

(6) TDRSS components (25) (double precision) - 25 TDRSS components that are not used by any program to date.

OBDATA

OBDATA is a file of identical numerical records with three header records that are not used. This file is one of the primary input files to the RADSELECT program. The numerical records are in the following order and represent the variables indicated:

(1) dummy (integer) - not used.

(2) dummy (double precision) - not used.

(3) time (double precision) - time of the record in seconds from midnight December 31 of the previous year.

(4) state vector (6 values) (double precision) - in order, X, Y, Z position, and X, Y, Z velocity. Position data is in feet; velocity data is in feet/second.

35.2.3 Execution Procedure

Normal setup of a production directory will copy the current version of RADSELECT into the production directory. Execution is accomplished by entering

radselect.x

Run time is approximately 20 minutes.

35.2.3.1 Sample Output

RADS66

The following is a compressed sample of the RADS66 file:

```
**** NLRADAR INPUT ****
   Start time:          42890.000  Stop time:          45830.000

     50      51       3      53      52      13      14      16      17      41
     44      20      19      42      54       0       1      46      47       2
      8       6       7       4      12      15      45      49      18      21
     23      22      28      29      27       5      11       9      10      25
     24      26      35      33      30      32      34      38      43      39
     40      31      48       0       0       0       0       0       0       0

   First onboard record has             0. time =      42890.000
  -4874989.84117239  -2744606.05193115   3052948.97883002
       200.14312659       -356.26346678         -.69020777
ID= 49 time=  42890.0 az= 6.06792 el=  .00083 rng=  13087.3502 cnts= -9999.0
     *** Completed radar file     1

   First onboard record has             0. time =      42890.000
  -4874989.84117239  -2744606.05193115   3052948.97883002
       200.14312659       -356.26346678         -.69020777
ID= 48 time=  42910.6 az= 6.13053 el=  .03927 rng=   8956.4767 cnts= -9999.0
     *** Completed radar file     2

   First onboard record has             0. time =      42890.000
  -4874989.84117239  -2744606.05193115   3052948.97883002
       200.14312659       -356.26346678         -.69020777
```

```
ID= 50 time=  42911.9 az= 1.81614 el=  .05867 rng=   7947.4220 cnts= -9999.0
     *** Completed radar file     3

   First onboard record has           0. time =      42890.000
  -4874989.84117239  -2744606.05193115   3052948.97883002
       200.14312659       -356.26346678         -.69020777
ID= 12 time= 42912.3 az= .66440 el= .03734 rng=  14306.2482
cnts=2935312559624.0
     *** Completed radar file    11

 table(1)=  1. # stations   45
 table(2)=  2. # stations   30
 table(3)=  3. # stations    4
 table(4)= 11. # stations    2
       Raecomp complete

          ****  RADAR TABLE  ****
  File id
           1
           2
           3
          11
       Statistics calculated
       Statistics calculated
       Statistics calculated
       Statistics calculated
File number  1 had  283 points edited.
       Bad blocks removed
File number  2 had  221 points edited.
       Bad blocks removed
  +++ File   3 closed. No records written.
       Bad blocks removed
File number  4 had   45 points edited.
       Bad blocks removed
       Statistics summed
       Statistics summed
```

```
    Statistics summed
    Statistics summed

**** File #    1 for file     1. with total points =   6662
    --- Time intervals:
              1.          42890.100          43098.600
              1.          43101.400          43560.000
    --- Averages are:
    ave: az=  1.657433 el=  -.000139 rng=      -6.8 dist=      79.5
  sigma: az=  2.705521 el=   .000358 rng=      17.3 dist=      68.4
**** File #    2 for file     2. with total points =   4544
    --- Time intervals:
              2.          42910.600          43098.600
              2.          43101.400          43370.000
    --- Averages are:
    ave: az=  1.369777 el=  -.000278 rng=      11.7 dist=      49.7
  sigma: az=  2.502949 el=   .000417 rng=      10.9 dist=      32.7
**** File #    3 for file     3. with total points =      0
    --- Time intervals:
    --- Averages are:
    ave: az=   .000000 el=   .000000 rng=        .0 dist=        .0
  sigma: az=   .000000 el=   .000000 rng=        .0 dist=        .0
**** File #    4 for file    11. with total points =   5119
    --- Time intervals:
             11.          42912.300          42979.900
             11.          43083.900          43240.000
             11.          43272.300          43560.200
    --- Averages are:
    ave: az=   .000156 el=   .000133 rng=      -2.1 dist=     260.3
  sigma: az=   .000343 el=   .000336 rng=      16.1 dist=      93.9
     +++++ Sorted time intervals +++++
 Index    file        start        stop
    Sband/Cband files merged
---- Cband 1 array:
   1    1.      42890.10      42910.00
   2    2.      42910.60      42920.00
```

```
          *** etc ***
   20    2.        43220.10       43360.00
   21    1.        43360.10       43560.00
---- # of elements:  21
---- Cband 2 array:
    1    1.        42910.10       42920.00
    2    2.        42920.10       42950.00
          *** etc ***
   19    1.        43220.10       43360.00
   20    2.        43360.10       43370.00
---- # of elements:  20
---- Cband 3 array:
---- # of elements:   0
---- Sband array:
    1   11.        42912.30       42979.90
    2   11.        43083.90       43240.00
    3   11.        43272.30       43560.20
---- # of elements:   3
 radselect complete
```

35.2.3.2 Definition of Outputs

AVE(i)

These files are intermediate files left by the process for traceback and malfunction analysis. The records in these files represent the averages of the various difference residuals for each ten second interval of radar data. These averages files give the means and standard deviations for each ten second interval wich are then the selection criteria for the radar assignment to TAPE11,TAPE12,TAPE13 and TAPE14. Each record has the following order:

(1) file number (integer) - the CB/SB file the data came from; 1,2,3,4 are from CB1,CB2,CB3,CB4 respectively; 11,12 are from SB1, SB2 respectively.

(2) number of stations (integer) - The number of changes in the radar stations in this block of data (10 seconds max).

(3) number of data points (integer) - a counter expressing the number of data points in this data block that were used to calculate the means and standard deviations.

(4) start time (double precision) - the start time of the data block in seconds from midnight day of launch. This time usually starts on an even ten seconds.

(5) stop time (double precision) - the stop time of the data block in seconds from midnight day of launch. This time usually stops on an even ten seconds.

(6) azimuth mean (double precision) - the mean of all the azimuth values from this radar file in this time interval, measured in radians.

(7) elevation mean (double precision) - the mean of all the elevation values from this radar file in this time interval, measured in radians.

(8) range mean (double precision) - the mean of all the range values from this radar file in this time interval, measured in meters.

(9) distance mean (double precision) - the mean of all the distance values from this radar file in this time interval, measured in meters.

(10) azimuth standard deviation (double precision) - the standard deviation of all the azimuth values from this radar file in this time interval, measured in radians.

(11) elevation standard deviation (double precision) - the standard deviation of all the elevation values from this file in this time interval, measured in radians.

(12) range standard deviation (double precision) - the standard deviation of

all the range values from this radar file in this time interval, measured in meters.

(13) distance standard deviation (double precision) - the standard deviation of all the distance values from this radar file in this time interval, measured in meters.

PLTDIF(i)/DIF(i)

These files are used for quality assurance purposes. The DIF[1-5] files are the differences between the filter output and the file used as the base input (OBDATA for first run, TAPE9 for the filter run). The PLTDIF files are plottable files identical to the DIF files with one exception. The values in the files have been chopped to preclude large plot values. Since scaling in the plot routine is automatic, large differences will drive the scales to values that prevent useful interpretation of the data. The limits are as follows: (1) range plus or minus 1000 meters, (2) distance 5000 meters, (3) azimuth/elevation plus or minus .0025 radians, (4) doppler plus or minus 1000 meters. The values on each record are in the following order and represent the values described:

(1) radar station ID (double precision) - the ID of the radar station used in this difference record.

(2) time (double precision) - time of the difference measurement measured in seconds from midnight day of launch.

(3) range difference (double precision) - the difference in range as measured by the radar and the base trajectory at the same time (meters).

(4) azimuth difference (double precision) - the difference in azimuth as measured by the radar and the base trajectory at the same time (radians).

(5) elevation difference (double precision) - the difference in elevation as measured by the radar and the base trajectory at the same time (radians).

(6) distance difference (double precision) - the difference in distance of the radius vector of the two positions as measured by the radar and the base trajectory at the same time (meters).

(7) doppler difference (double precision) - the difference in doppler range measurement as calculated by the process from radar and the base trajectory at the same time (meters).

TAPE11/TAPE12/TAPE13

These three files are primary output files generated in RADSELECT and represent the C-band radar inputs to the filter. The last time in the file is 1.0d30 to signal the end of the file to LRBET5. The records contain the following elements as ordered:

(1) time (double precision) - time in seconds measured from midnight day of launch.

(2) station ID (integer) - the radar station TRWID as collected from the raw data file.

(3) C-band range (double precision) - the range measurement in meters as measured at time (1).

(4) C-band azimuth (double precision) - the azimuth measurement in radians as measured at time (1).

(5) C-band elevation (double precision) - the elevation measurement in radians as measured at time (1).

TAPE14

TAPE14 is a primary output file similar to TAPE11, TAPE12, and TAPE13 generated in RADSELECT. This file represents the S-band radar inputs to the filter. The last time in the file is 1.0d30 to signal the end of the file to LRBET5. The records contain the following elements as ordered:

(1) time (double precision) - time in seconds measured from midnight day of launch.

(2) station ID (integer) - the radar station TRWID as collected from the data file.

(3) S-band range (double precision) - the range measurement in meters as measured at time (1).

(4) S-band doppler counts (double precision) - the doppler counts in frequency shift in cycles as measured at time (1).

35.2.4 Messages

There is only one message written by the program to the screen at normal termination of the following form:

```
radselect complete
```

36.0 RAECOMP

36.1 RAECOMP FUNCTIONAL DESCRIPTION

RAECOMP is an analysis program to evaluate the radar data as compared to the OBDATA (onboard data) input trajectory. The program initializes with the OBDATA trajectory, translates the Mean-of-50 coordinates position to the equivalent range, azimuth, and elevation of an available radar station. Differences in the actual values of the radar station and the translated values are calculated and stored. In addition, the difference in the magnitude of the two position vectors is calculated and the four time tagged items are saved in an output file. When all the available radars have been used, the program terminates. The difference files are used as inputs to a plot routine. The functions of the program are as follows:

(1) Initialize OBDATA trajectory.

(2) Open and read the first radar file.

(3) calculate the range, azimuth, elevation using the base radar station coordinates.

(4) Calculate the differences in range, azimuth, elevation, distance, and Doppler (s-band only).

(5) Save the differences and cycle to the next position.

(6) After completion of one radar station data file, cycle to the next radar staion file and repeat steps (1) to (5).

36.2 RAECOMP OPERATIONAL DESCRIPTION

The normal setup of a flight directory will preload the executable code. This program is not in the normal stream of the Ascent/Descent flow. This is a program which allows the user to manually evaluate a radar selection when no filter runs have been accomplished. It uses the onboard trajectory (OBDATA) to evaluate the radars. Proper execution of INPUT will generate the input file, RAECOMP.IN. Proper execution of a UN2HP using the onboard data tape will generate the input file OBDATA. Execution of RDRMRG will generate the RAEPOS(i) files and the intermediate file TABLE. Execution should occur in the directory where the input files are located.

36.2.1 Equipment Configuration

There are no special restrictions on equipment configuration other than normal setup procedures and proper execution of prerequisite programs.

36.2.2 Input Items

The input consists of the files RAECOMP.IN, RAEPOS(i), OBDATA, and TABLE.

RAECOMP.IN

RAECOMP.IN is a binary file from the menu driven input routine.

RAEPOS(i)

RAEPOS(i) are individual radar station files of the data from each station. Basically they are unblocked radar data, separated by station. The files are binary.

OBDATA

OBDATA is a binary file that is the primary input of the onboard data tape. It contain the trajectory that is compared to the radar data.

TABLE

TABLE is a binary file of the table of radars ID's, start time, and stop time of each station on the raw radar tape.

36.2.2.2 Definition of Inputs

RAECOMP.IN

RAECOMP.IN is a binary file and is an input file for RAECOMP. It is composed of four arrays and a number in one record arranged as follows:

(1) cuvw matrix (double precision) (6,6) - The initial covariance matrix written in column major order.

(2) P array (double precision) (540) - The p array for the LRBET5 filter.

(3) PS array (double precision) (372) - the ps array contains the radar station data for the LRBET5 filter.

(4) x array (double precision) (20) - The x array contains the initial state vector data for LRBET5.

(5) number of days (double precision) - The number of days since Dec 31 (eg., Jan 12 is day 12).

RAEPOS(i)

These files are generated in the process of reading the radar files from the raw radar tape file. There is one file for each radar on the raw radar tape file. Each file is a series of multiple records in the same format. The format is as follows:

(1) station ID number (double precision) - the TRWID number of the radar station. Numbers under 100 are high rate (tenth second data) stations. Stations over 100 are low rate stations and are normally S-band stations.

(2) time (double precision) - the time tag of the data on the record. The data is time tagged in seconds from midnight day of launch.

(3) azimuth (double precision) - this measurement is an azimuth angle measurement. Measurements are in radians.

(4) elevation (double precision) - this measurement is an elevation angle measurement. Measurements are in radians.

(5) range (double precision) - the range measurement for that time interval. Data is measured in feet.

(6) Doppler counts double precision - this measurement is the Doppler counts for the S-band stations; it has no value for a C-band station. The measurement is dimensionless.

OBDATA

OBDATA is a file of identical records that are in the following order:

(1) dummy (integer) - not used.

(2) dummy (double precision) - not used.

(3) time (double precision) - time of the record in seconds from midnight December 31 of the previous year.

(4) state vector (6 values) (double precision) - in order, X, Y, Z position, and X,Y,Z velocity. Position data is in feet; velocity data is in

feet/second.

TABLE

This file is an intermediate file to pass information from RDRMRG to RAECOMP. It is left in the directory for malfuntion analysis and information purposes. The first record consists of only one number (integer). That number is the number of radar stations detected (which is also the number of RAEPOS(i) files present). All other records contain three double precision numbers:

(1) station ID - the radar station id(TRWID) is presented.

(2) start time - the start time of the data from the radar station in seconds from midnight day of launch.

(3) stop time - the stop time of the data from the radar station in seconds from midnight day of launch.

36.2.3 Execution Procedure

Normal entry to a production directory (i.e., login to Adprodct) will establish the correct PATH for executing RAECOMP. Execution is accomplished by entering

```
raecomp.x
```

Run time is approximately 5 minutes per radar station file depending on other users.

36.2.3.1 Sample Output

RAE66

The following is a sample of the formatted debug file for RAECOMP:

```
 opening file    1
                                       the cuvw matrix is
 .132000E+03  .000000E+00  .000000E+00  .000000E+00 -.940000E+00  .000000E+00
 .000000E+00  .100000E+04  .000000E+00 -.990000E+00  .000000E+00  .000000E+00
 .000000E+00  .000000E+00  .660000E+02  .000000E+00  .000000E+00  .000000E+00
 .000000E+00  .000000E+00  .000000E+00  .115000E+01  .000000E+00  .000000E+00
 .000000E+00  .000000E+00  .000000E+00  .000000E+00  .120000E+00  .000000E+00
 .000000E+00  .000000E+00  .000000E+00  .000000E+00  .000000E+00  .800000E-01

TRW id     Start          Stop
     7.      568192.70      568707.90
    22.      568062.30      568802.00
    23.      568024.10      568351.70
    29.      567151.40      567483.50
    37.      568015.70      568734.90
    39.      567377.10      568744.30
    40.      568047.20      568360.20
   108.      566400.00      566770.00

  id   ips                         the ps values are
  1    1  .299215E+0  .520470E+1 -.3310E+2  .0000E+0  .17590E+5  .0000000000E+00
  2    7  .564580E+0  .515477E+1 -.3525E+2  .3410E-3  .71411E+4  .0000000000E+00
  3   13  .564638E+0  .515469E+1 -.3375E+2  .3410E-3  .71381E+4  .2106384288E+10
  4   19  .603583E+0  .417899E+1  .6011E+3  .3020E-3  .70080E+4  .0000000000E+00

             --- (etc., for 60 Radar stations in file RADAR) ---

 60  355  .000000E+0  .000000E+0  .0000E+0  .0000E+0  .00000E+0  .0000000000E+00
 61  361  .608971E+0 -.205787E+1  .6463E+3  .6092E+0 -.20572E+1  .6417289680E+03
```

```
 62  367  .000000E+0  .175900E+5  .4157E+1  .4158E+1  .00000E+0  .0000000000E+00

index            the P array values array
  1  .572957E+02  .100000E+02  .100000E-03  .100000E+1  .180000E+04  .300000E+02
  7  .200000E+01  .299792E+09  .729211E-04  .637813E+7  .108262E-02  .398600E+15
 13  .490278E+13  .132712E+21  .398615E+15  .637816E+7  .335232E-02  .637800E+07

          --- (etc., The rest of the P array ) ---

289  .000000E+00  .000000E+00  .000000E+00  .000000E+0  .000000E+00  .000000E+00
295  .000000E+00  .000000E+00  .000000E+00  .000000E+0  .000000E+00  .000000E+00

                  at t= .5648600000E+06 the initial state vector is
 .5846678E+7 -.6973020E+6 -.3201586E+7  .1075824E+4  .7636811E+4  .3181832E+3
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0

 start reading data
   First OB tape record has      564851. time =     564850.645
 5836534.93476708    -769897.93090623  -3204566.12315689
    1148.93542865       7627.08431301       277.89262258

               at t= .5648506453E+06 the initial state vector is
 .5836534E+7 -.7698979E+6 -.3204566E+7  .1148935E+4  .7627084E+4  .2778926E+3
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0

ID=  7 time= 568192.7 az= -1.878 el=  .074 rng=   372964.0 cnts=  3553202754517.
idcl=    7 idcll=    7 learid=   14 idin=      7.
initial ips=    79

     *** Completed radar station     7

First OB tape record has      564851. time =     564850.645
```

```
5836534.93476708    -769897.93090623  -3204566.12315689
   1148.93542865       7627.08431301        277.89262258

                 at t= .5648506453E+06 the initial state vector is
 .5836534E+7 -.7698979E+6 -.3204566E+7  .1148935E+04  .7627084E+4  .2778926E+3
 .0000000E+0  .0000000E+0  .0000000E+0  .0000000E+00  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0  .0000000E+0  .1000000E+65  .0000000E+0  .0000000E+0
 .0000000E+0  .0000000E+0

ID= 22 time=  568062.3 az=  4.278 el=  .126 rng=  319218.4 cnts=       -9999.
idcl=   22 idcll=   22 learid=    6 idin=     22.
initial ips=    31

     *** Completed radar station    22

     --- (etc., For each radar station file ) ---
```

36.2.3.2 Definition of Outputs

DIFFER(i)

These files are used for plot program input purposes. The DIFFER(i) files are the differences between the onboard trajectory and the file used as the base radar input. The values on each record are:

(1) radar station ID (double precision) - the ID of the radar station used in this difference record.

(2) time (double precision) - time of the difference measurement measured in seconds from midnight day of launch.

(3) range difference (double precision) - the difference in range as measured by the radar and the base trajectory at the same time (meters).

(4) azimuth difference (double precision) - the difference in azimuth as measured by the radar and the base trajectory at the same time (radians).

(5) elevation difference (double precision) - the difference in elevation as measured by the radar and the base trajectory at the same time (radians).

(6) distance difference (double precision) - the difference in distance of the radius vector of the two positions as measured by the radar and the base trajectory at the same time (meters).

(7) Doppler difference (double precision) - the difference in Doppler range measurement as calculated by the process from radar and the base trajectory at the same time (meters).

36.2.4 Messages

None.

37.0 RDRMRG

37.1 RDRMRG FUNCTIONAL DESCRIPTION

RDRMRG is a configured program and is included in the shell script AUTOSELECT. The progam accepts raw radar data from the RDRDATA file, and unblocks the data into the RAEPOS(i) files. The RAEPOS(i) files are unblocked radar data from the same radar station in binary record format. The RAEPOS(i) files are then merged into radar files of continuous data similar to the MCC usage. These files are the CB[1-4]/SB[1-2] files. The functions performed by the program are as follows:

(1) Read the raw radar file, RDRDATA, and unblock the data into individual radar files (RAEPOS(i)).

(2) Convert the X/Y keyhole angle data of the S-band stations to azimuth and elevation data like the C-band stations.

(3) Search the table of radar stations to locate duplicate low/high rate stations.

(4) Remove the low rate data file when a high rate data file exists for the same station.

(5) Generate the TABLE file of radar stations available for LRRESID to use for QA processing.

(6) Merge the radar data into CB[1-4]/SB[1-2] files to match the MCC usage.

37.2 RDRMRG OPERATIONAL DESCRIPTION

The executable configured code is in /users/Adheaven/EXECUTE. A normal setup of the flight production directory will move a copy of the executable code to the flight directory. For individual execution (outside of shell script

AUTOSELECT operations), the file, RDRDATA, must be in the directory. The primary output files are CB[1-4]/SB[1-2]. The quality assurance output file is RADM66. RADM66 is a formatted file and is used for quick analysis of the results of the program. Data files, TABLE and RAEPOS(i), are used as inputs to LRRESID for QA purposes.

37.2.1 Equipment Configuration

No special configuration is required to execute RDRMRG.

37.2.2 Input Items

The only file required for execution is RDRDATA.

37.2.2.1 Sample Input

The file RDRDATA is a binary file generated from a UN2HP execution using the raw radar tape as an input.

37.2.2.2 Definition of Inputs

RDRDATA is a file of blocked identical numerical records with one header record. The blocking factor is 125 numerical records. The header record is 81 characters and is not used for any purpose. Each new radar station will begin a new block. When data ends on a radar station before a block ends, the rest of the block is filled with -9999.d0 for every word in the record. Each record has the following data in the order listed:

(1) record count (double precision) - the record number in the block (1-125)

(2) station ID number (double precision) - the TRWID number of the radar station. Numbers under 100 are high rate(tenth second data) stations.

Stations over 100 are low rate stations and are normally S-band stations. It is possible to get high rate and low rate data from the same station on this file. If this occurs the high rate data will be processed.

(3) time (double precision) - the time tag of the data on the record. The data is time taged in seconds from midnight the day of launch.

(4) range (double precision) - the range measurement for that time interval. Data is measured in feet.

(5) elevation or X angle (double precision) - this measurement is an angle measurement. Elevation is measured on all C-band stations; X angle of the keyhole measurement for all S-band stations. Measurements are in radians.

(6) azimuth or Y angle (double precision) - this measurement is an angle measurement. Azimuth is measured on all C-band stations; Y angle of the keyhole measurement for all S-band stations. Measurements are in radians.

(7) Doppler counts (double precision) - this measurement is the Doppler counts for the S-band stations; it has no value for a C-band station. The measurement is dimensionless.

(8) station frequency (double precision) - this measurement contains the frequency of the S-band stations and is undefined for the C-band stations. The data is not used.

37.2.3 Execution Procedure

Normal setup of a production directory will copy the current version of RDRMRG into the production directory. Execution is accomplished by entering

```
rdrmrg.x
```

Run time is approximately three minutes.

37.2.3.1 Sample Output

RADM66

The following is a compressed sample of RADM66 output:

```
 Number of stations used is  10
sta        start time       stop time
  3         43272.300        43560.200
 12         42912.300        43244.500
 20         43298.900        43591.400
 21         42942.600        43025.700
 25         43042.300        43396.900
 30         42929.800        43272.300
 32         42937.100        43392.400
 48         42910.600        43162.600
 49         42408.900        42958.100
 50         42911.900        43025.800
t =     42408.900   opened station  49
t =     42910.600   opened station  48
t =     42911.900   opened station  50
        *** etc ***
t =     43392.500   closed station  32
t =     43397.000   closed station  25
t =     43560.300   closed station   3
t = ************    closed station  20
      cbl
sta        start time       stop time
 49         42408.900        42912.400
 50         42912.400        42915.300
 32         43246.900        43249.200
           **** etc ****
```

30	43267.700	43272.300
32	43272.400	43298.800
20	43298.900	43591.400

cb2

sta	start time	stop time
48	42910.600	42929.700
30	42929.800	42939.900
50	42940.000	42941.400
	*** etc ***	
32	43386.900	43388.600
25	43388.700	43395.200
25	43396.300	43396.900

cb3

sta	start time	stop time
50	42911.900	42912.300
32	42937.100	42937.500
25	43380.300	43380.300
32	43389.900	43390.200
32	43391.500	43392.400

cb4

sta	start time	stop time

sb1

sta	start time	stop time
12	42912.300	42979.900
12	43083.900	43244.500
3	43272.300	43560.200

sb2

sta	start time	stop time

total not used 0

CB[1-4]/SB[1-2]

CB[1-4]/SB[1-2] are sequential binary output radar files and contain the TRWID station number, radar range, azimuth, elevation and doppler data for each time interval where data is available.

TABLE

TABLE is a binary file of the table of radars ID's, start time, and stop time of each station on the raw radar tape.

RAEPOS(i)

RAEPOS(i) are individual radar station files of the data from each station. Basically it is unblocked and separated radar data by station. The files are binary.

37.2.3.2 Definition of Outputs

CB[1-4]/SB[1-2]

These files contain the radar data from different stations merged together to form continuous tracking. When only one radar station is available, then the lowest numbered file is selected to contain data. S-band data is on SB1 and SB2; C-band data is on CB1, CB2, CB3, then CB4 in that order. All the files are not necessary for operation of the program. Usually CB1, CB2 and SB1 will be large files with CB3 having little data in it. CB4 and SB2 are overflow files and normally not used. The files consist of multiple identical records of the following data items:

(1) station ID number (double precision) - the TRWID number of the radar station. Numbers under 100 are high rate(tenth second data) stations. Stations over 100 are low rate stations and are normally S-band stations.

(2) time (double precision) - the time tag of the data on the record. The data is time taged in seconds from midnight the day of launch.

(3) azimuth (double precision) - this measurement is an azimuth angle measurement. Measurements are in radians.

(4) elevation (double precision) - this measurement is an elevation angle measurement. Measurements are in radians.

(5) range (double precision) - the range measurement for that time interval. Data is measured in meters.

(6) Doppler counts (double precision) - this measurement is the Doppler counts for the S-band stations; it has no value for a C-band station. The measurement is dimensionless.

TABLE

This file is an intermediate file to pass information from RDRMRG to LRRESID. It is left in the directory for malfuntion analysis and information purposes. It is composed of two different records. (1) The first is only one record and consists of only one number(integer). That number is the number of radar stations detected and merged onto the CB/SB files. Also, it is the same number of RAEPOS(i) files generated. (2) The second record type has three numbers, all double precision. This record type gives the following information on each radar station on the raw radar tape:

(1) station ID - the radar station id(TRWID) is presented.

(2) start time - the start time of the data from the radar station is presented in seconds from midnight day of launch.

(3) stop time - the stop time of the data from the radar station is presented in seconds from midnight day of launch.

RAEPOS(i)

These files are generated in the process of reading the radar files from the raw radar tape file. They are intermediate files since they are used in the LRRESID program for QA purposes. There is one file for each radar on the raw radar tape file. Each file is a series of multiple records in the same format. The format is as follows:

(1) station ID number (double precision) - the TRWID number of the radar station. Numbers under 100 are high rate (tenth second data) stations. Stations over 100 are low rate stations and are normally S-band stations.

(2) time (double precision) - the time tag of the data on the record. The data is time tagged in seconds from midnight the day of launch.

(3) azimuth (double precision) - this measurement is an azimuth angle measurement. Measurements are in radians.

(4) elevation (double precision) - this measurement is an elevation angle measurement. Measurements are in radians.

(5) range (double precision) - the range measurement for that time interval. Data is measured in feet.

(6) Doppler counts (double precision) - this measurement is the Doppler counts for the S-band stations; it has no value for a C-band station. The measurement is dimensionless.

37.2.4 Messages

No messages are generated in this program.

38.0 READADATA

38.1 READATA FUNCTIONAL DESCRIPTION

This program is user interactive. READATA is a backup utility used in the processing of anomlies and glitches in the processing of the Ascent/Descent program. The program is used to read and display most of the binary input/output files generated in the normal processing of the Ascent/Descent products. The binary files are converted to a formatted file for output. Normally, code words and explanatory phrases are also added to the output file.

38.2 READATA OPERATIONAL DESCRIPTION

The program is configured in the /users/Adheaven/Utilities subdirectory. The user has the choice of selecting the appropriate input file name and the generic file type. The program then generates a formatted file of the input binary file and returns it to the screen.

38.2.1 Equipment Configuration

The program must be executed in the directory containing the input binary file. The PATH must be such that the /users/Adheaven/Utilities directory will be accessed to find READATA.

38.2.2.2 Input Items

All the input files are discussed in the output files of the program that generates the file. See those Paragraphs for detailed input descriptions.

Upon execution, the program will respond with the following request:

"what type file is it?
enter one of the following
attdat,aveX,beadat,differ,imu,msbls,obdata
raepos,rdrdata,table,taperdr,tape9,trjattdat"

Any selection other than "table" will result in the following requests by the program:

"what file do you want to read?"

The correct response is the file name of the file to be read. If the file is not in the directory where the execution is initiated then a more formal file name is required including the full or sufficient file name including the directories. If a file name is entered that does not match any file, then an I/O error will result and the program will abort. After the filename is entered, the following request is presented:

"start at the beginning of the file? (y/n)"

If the response is a "n", then the program responds with the following request:

"at what time do you wish to start printing?"

At this point, the program is looking for a time to start the formatted print. A time prior to the first time in the file will cause the entire file to be printed. A time after the end time on the file will cause no data to be output. A "y" response to the previous request causes all of the data to be formatted and displayed. At this time the program begins the search for the entered file type (e.g., attdat,aveX, etc). If no match is found, the program terminates. If a match is found, a subroutine is called to read and write the output. Several of the data types ask supplimentary questions of the user. The following sections document those requests.

(1) Type "trjattdat" : Since this is a large file of printed data, it is possible to shorten the output to only the necessary data elements. The first

request is as follows:

"Desire to read the header record? (y/n)"

The "y" causes the first record to be read and discarded. The "n" response disregards the request. The next request is as follows:

"Enter the choices for print outs
enter a 1 to print the variable, a 0 to not print
(1) M50 position?"

Entry of a "1" causes the print of the position data; entry of a "0" causes the position data to be omitted in the output. This prompt and expected response continues, one at a time, for:

"(2) M50 velocity?"

"(3) M50 sensed acceleration?"

"(4) M50 angular position?"

"(5) M50 angular rates?"

"(6) M50 angular acceleration?"

"(7) covariance matrix?"

"(8) body cgs?"

"(9) primary imu code ?"

"(10) M50 to body transformation?"

"(11) M50 quaternion ?"

(2) Type "obdata" : The first request is as follows:

"Do you desire a plotfile called obdatplt? y/n"

A "y" opens a file suitable for plotting in addition to the formatted print file. A "n" deletes this capability. The next request is as follows:

"Enter the day of launch from Jan 1"

This entry is to modify the time on the OBDATA file to make it compatible to launch data times. The formatted print file times are corrected to mission launch day seconds and position/velocity data converted to meters.

The next several file types result in asking the user if a plot file is required, in addition to a print file.

(3) Type "aveX" : causes the prompt:

"Do you desire a plotfile called rdaveXplt? y/n"

(4) Type "beadat" : causes the prompt:

"Do you desire a plotfile called rdbeaquat? y/n"

(5) Type "taperdr" : causes the prompt:

"Do you desire a plotfile called rdtaperdr? y/n"

This type of file has a limitation in that execution <u>must</u> be in the directory where the input TAPE14 file resides in order to properly print out.

38.2.3.1 Sample Output

Data is sent to the screen for all printed outputs. To capture the output to the screen a UNIX 'pipeline' or 'redirect' must be accomplished. A redirection is a little difficult with an interactive program but can be done by prior knowledge of the expected responses as inputs.

Response to "attdat" type entry:

```
 opening attdata
 testing  attdat
    564860.8853
         -.0895         .3812        -.3636         .8453
          .0342        -.7629         .6447         .0333
          .0543         .3830        -.2819        -.8780
    564861.8453
         -.0897         .3812        -.3638         .8452
          .0344        -.7630         .6446         .0334
          .0544         .3831        -.2817        -.8780
    564862.8053
         -.0899         .3811        -.3640         .8451
          .0346        -.7631         .6445         .0336
          .0544         .3832        -.2813        -.8781
    (etc.)
```

Response to "aveX" type entry:

```
 opening ave1
 testing  attdat
 testing  aveX
    1     1    100      567390.1      567400.0
       6.283210          -.000460       -265.206411        628.588963
        .000395           .000438         80.793891        226.687111
    1     1    100      567400.1      567410.0
       6.283004          -.000162       -194.053736        740.425453
        .000413           .000731        269.322781        244.570155
    1     1    100      567410.1      567420.0
       5.654957           .000043         56.930424        437.117055
       1.894474           .000451         23.374225        268.309539
```

```
1      1   100      567420.1       567430.0
      .000132             -.000373           48.276480          523.364429
      .000354              .000442            3.777317          222.560484
1      1    44      568015.7       568020.0
     6.283144             -.000461          -32.846238          385.665399
      .000320              .000272           12.144730          191.436314
(etc.)
```

Response to "beadat" type entry:

```
opening beadata
testing  attdat
testing  aveX
testing  beadat
   564860.8853   7   6    .54816652    .41157079   -.70275819    .19040451
   564861.8453   7   6    .54806134    .41178435   -.70270119    .19045593
   564862.8053   7   6    .54783191    .41207086   -.70273692    .19036444
   564863.7653   7   6    .54767988    .41231129   -.70273347    .19029402
   564864.7253   7   6    .54750127    .41255445   -.70275654    .19019577
   564865.6853   7   6    .54731712    .41281368   -.70273986    .19022492
   564866.6453   7   6    .54713585    .41306482   -.70274272    .19019063
   564867.6053   7   6    .54692696    .41331865   -.70277320    .19012739
  (etc.)
```

Response to "differ" type entry:

```
opening difl
testing  attdat
testing  aveX
testing  beadat
testing  differ
29. 567151.4  -61572.203   6.271155   6.277491   66932.237          .0
29. 567151.5  -61523.057   6.271165   6.277502   66873.150          .0
29. 567151.6  -61473.874   6.271175   6.277513   66813.967          .0
```

```
29. 567151.7  -61426.528   6.271185   6.277512   66760.551          .0
29. 567151.8  -61377.445   6.271195   6.277523   66701.638          .0
29. 567151.9  -61328.411   6.271204   6.277534   66642.863          .0
29. 567152.0  -61281.214   6.271214   6.277545   66585.866          .0
29. 567152.1  -61232.280   6.271224   6.277544   66531.339          .0
29. 567152.2  -61183.396   6.271233   6.277554   66472.973          .0
29. 567152.3  -61134.563   6.271242   6.277565   66414.744          .0
29. 567152.4  -61087.565   6.271252   6.277564   66362.252          .0
   (etc.)
```

Response to "imu" type entry:

```
 opening tape10
 testing  attdat
 testing  aveX
 testing  beadat
 testing  differ
 testing imu
564870.80 .96  .036 -.162 -.140  .049 -.170 -.165  .058 -.158 -.156
564871.76 .96  .115 -.387 -.368  .102 -.387 -.366  .107 -.382 -.379
564872.72 .96  .101 -.384 -.373  .109 -.377 -.373  .110 -.383 -.354
564873.68 .96  .108 -.379 -.366  .102 -.387 -.366  .099 -.379 -.378
564874.64 .96  .108 -.379 -.366  .109 -.377 -.373  .101 -.380 -.363
564875.60 .96  .101 -.384 -.373  .099 -.380 -.372  .107 -.382 -.379
564876.56 .96  .112 -.373 -.374  .109 -.377 -.373  .107 -.382 -.379
564877.52 .96  .101 -.384 -.373  .109 -.377 -.373  .099 -.379 -.378
564878.48 .96  .112 -.373 -.374  .099 -.380 -.372  .110 -.372 -.377
564879.44 .96  .098 -.371 -.379  .109 -.377 -.373  .110 -.372 -.377
564880.40 .96  .112 -.373 -.374  .109 -.377 -.373  .099 -.379 -.378
   (etc.)
```

Response to "msbls" type entry:

```
 opening tape16
```

```
testing  attdat
testing  aveX
testing  beadat
testing  differ
testing  imu
testing  msbls
   568666.1653          15018.1566
   568666.1653          15015.0336
   568667.1253          14826.0917
   568667.1253          14830.7762
   568668.0853          14652.7648
   568668.0853          14652.7648
   568669.2053          14465.3844
   568669.2053          14468.5074
   568670.1653          14287.3730
   568670.1653          14290.4960
   (etc.)
```

Response to "obdata" type entry:

```
opening obdata
testing  attdat
testing  aveX
testing  beadat
testing  differ
testing  imu
testing  msbls
testing  obdata
t =   564568.405
        pos =        5213080.690       -2844749.521       -3113767.314
        vel =       3229.7298962       6946.5147202       -915.4043035
t =   564569.365
        pos =        5216178.002       -2838079.199       -3114644.203
        vel =       3223.0885898       6950.0865953       -911.4386292
t =   564570.325
```

```
          pos =        5219268.992        -2831405.389        -3115517.278
          vel =        3216.4734773       6953.6834734        -907.4694575
t =   564572.245
          pos =        5225431.914        -2818047.402        -3117252.015
          vel =        3203.2361083       6960.8867548        -899.5476340
t =   564573.205
          pos =        5228503.786        -2811363.295        -3118113.672
          vel =        3196.5793239       6964.4252923        -895.5734765
t =   564574.165
          pos =        5231569.320        -2804675.736        -3118971.515
          vel =        3189.9487332       6967.9888330        -891.6011050
      (etc.)
```

Response to "raepos" type entry:

```
opening raeposl
testing  attdat
testing  aveX
testing  beadat
testing  differ
testing  imu
testing  msbls
testing  obdata
testing  raepos
  7.    568192.7     -1.878257      .074728  1223635.3503553202754517.00
  7.    568192.8     -1.878337      .074755  1223088.9763553229309745.00
  7.    568192.9     -1.878524      .074802  1222534.7343553255863633.00
  7.    568193.0     -1.878641      .074829  1221990.3273553282416093.00
  7.    568193.1     -1.878734      .074851  1221437.5603553308967129.00
  7.    568193.2     -1.878944      .074904  1220892.1703553335516777.00
  7.    568193.3     -1.879025      .074927  1220342.8453553362065064.00
    (etc.)
```

Response to "rdrdata" type entry:

```
opening rdrdata
testing  attdat
testing  aveX
testing  beadat
testing  differ
testing  imu
testing  msbls
testing  obdata
testing  raepos
testing  rdrdata
station=   7.
   568192.700     1223635.350  1.328284 -1.254664
    3553202754517.0    2106406300.000000
station=   7.
   568205.200     1157390.354  1.328547 -1.235454
    3556510875265.0    2106406300.000000
station=   7.
   568217.700     1096297.305  1.332154 -1.211773
    3559795066153.0    2106406300.000000
station=   7.
   568230.200     1039732.126  1.335510 -1.185168
    3563058157073.0    2106406300.000000
station=   7.
   568242.700      985402.604  1.337236 -1.159833
    3566310834897.0    2106406300.000000
   (etc.)
```

Response to "table" type entry:

```
testing  attdat
testing  aveX
testing  beadat
testing  differ
```

```
testing  imu
testing  msbls
testing  obdata
testing  raepos
testing  rdrdata
testing  table
Number of stations is   8
id is    7. start time is     568192.700 stop time is      568707.900
id is   22. start time is     568062.300 stop time is      568802.000
id is   23. start time is     568024.100 stop time is      568351.700
id is   29. start time is     567151.400 stop time is      567483.500
id is   37. start time is     568015.700 stop time is      568734.900
id is   39. start time is     567377.100 stop time is      568744.300
id is   40. start time is     568047.200 stop time is      568360.200
id is  108. start time is     566400.000 stop time is      566770.000
testing  taperdr
testing  tape9
testing  trjattdat
```

Response to "taperdr" type entry:

(1) When the tape file is a c-band station the following results:

```
opening tape11
testing  attdat
testing  aveX
testing  beadat
testing  differ
testing  imu
testing  msbls
testing  obdata
testing  raepos
testing  rdrdata
testing  table
testing  taperdr
t =  567482.0000 with id of  18
```

```
range=          965190.2885 azimuth=    .45865 elevation=   6.27608
t =  567483.0000 with id of  18
range=          968940.7573 azimuth=    .46519 elevation=   6.27452
t =  568016.0000 with id of  11
range=          696062.0055 azimuth=   4.40199 elevation=    .02180
t =  568018.0000 with id of  11
range=          689671.9210 azimuth=   4.40256 elevation=    .02233
t =  568019.0000 with id of  11
range=          686510.8116 azimuth=   4.40256 elevation=    .02261
t =  568020.0000 with id of  11
range=          683331.8428 azimuth=   4.40290 elevation=    .02348
t =  568025.0000 with id of   7
range=          426122.9068 azimuth=   4.29163 elevation=    .08330
t =  568026.0000 with id of   7
range=          423010.0177 azimuth=   4.29187 elevation=    .08393
    (etc.)
```

(2) When the tape file is a s-band station the following results:

```
 opening tape14
 testing  attdat
 testing  aveX
 testing  beadat
 testing  differ
 testing  imu
 testing  msbls
 testing  obdata
 testing  raepos
 testing  rdrdata
 testing  table
 testing  taperdr
t =  566560.0000 with id of  16
range =          226168.8610 doppler =       2542832582676.0
t =  566570.0000 with id of  16
range =          196838.3616 doppler =       2545680148456.0
t =  568193.0000 with id of  14
```

```
range =          372462.6563 doppler =       3553282416093.0
t =  568194.0000 with id of  14
range =          370793.4116 doppler =       3553547862254.0
t =  568195.0000 with id of  14
range =          369136.4584 doppler =       3553813165126.0
   (etc.)
```

Response to "tape9" type entry:

```
 opening tape9
 testing  attdat
 testing  aveX
 testing  beadat
 testing  differ
 testing  imu
 testing  msbls
 testing  obdata
 testing  raepos
 testing  rdrdata
 testing  table
 testing  taperdr
 testing  tape9
t =  564860.0000
x 1-6. =     5846703.36752027    -697366.37747863   -3201606.02297687
                1075.95608195      7636.75217732       318.07572380
x 7-12 =       -.000060426069      .000602022938      -.000318708165
               -.015143720518    -.000000040777      -.000000085981
x 13-18=       -.011577328847      .000000000000       .093570697019
          *******************      .000000000000       .000000000000
x 19-20=        .000000000000      .000000000000
a. s =       -.000003517470      .000020951028      -.000025097300
acc. =      -7.739390915816      .923067577183      4.250274808866
c0,0=  17561.7887126 31957.85061527-4910.49622554 -37.49722976  -7.78953802
       31957.85061527************** -767.71081927 -191.36725735  18.82766081
       -4910.49622554 -767.71081927 6267.54073034   4.05511133    5.84894255
```

C-4

	-37.49722976	-191.36725735	4.05511133	.19375204	-.01285322
	-7.78953802	18.82766081	5.84894255	-.01285322	.01344507
c0,5=	20.09352349	-.00398928	.00261671	-.00124168	.03827312
	108.75099693	-.00051575	.00562734	.02449913	.32970100
	-1.65490022	.00371588	-.00111679	-.00007258	-.00578148
	-.10519123	-.00000560	-.00000446	-.00002866	-.00034335
	.00773345	.00000260	-.00000068	.00000505	.00004323
c 0,10=	.00000002	-.00000023	.02194865	.00000000	-9.56460894
	.00000004	-.00000160	.18631698	.00000000	-42.75674852
	.00000004	-.00000004	-.00272426	.00000000	-.80834980
	.00000000	.00000000	-.00019847	.00000000	.03705656
	.00000000	.00000000	.00002462	.00000000	-.00166779
c 0,15=	134.77992743	.00000000	.00000000	.00000000	.00000000
	7597.49087735	.00000000	.00000000	.00000000	.00000000
	552.02680004	.00000000	.00000000	.00000000	.00000000
	-7.35789262	.00000000	.00000000	.00000000	.00000000
	1.87318937	.00000000	.00000000	.00000000	.00000000
c 5, 0=	20.09352349	108.75099693	-1.65490022	-.10519123	.00773345
	-.00398928	-.00051575	.00371588	-.00000560	.00000260
	.00261671	.00562734	-.00111679	-.00000446	-.00000068
	-.00124168	.02449913	-.00007258	-.00002866	.00000505
	.03827312	.32970100	-.00578148	-.00034335	.00004323
c 5, 5=	.06485597	.00000735	.00000193	.00001456	.00015770
	.00000735	.00000017	.00000001	.00000000	.00000017
	.00000193	.00000001	.00000026	.00000004	.00000014
	.00001456	.00000000	.00000004	.00000023	.00000003
	.00015770	.00000017	.00000014	.00000003	1043.99987823
c 5,10=	.00000000	.00000000	.00008392	.00000000	-.01815757
	.00000000	.00000000	.00000011	.00000000	-.00001120
	.00000000	.00000000	.00000009	.00000000	.00000478
	.00000000	.00000000	.00000002	.00000000	-.00000352
	.00000000	.00000000	.00000928	.00000000	.00006343
c 5,15=	4.17535045	.00000000	.00000000	.00000000	.00000000
	.00081758	.00000000	.00000000	.00000000	.00000000
	.00167917	.00000000	.00000000	.00000000	.00000000
	.00070458	.00000000	.00000000	.00000000	.00000000

	.02333736	.00000000	.00000000	.00000000	.00000000
c10, 0=	.00000002	.00000004	.00000004	.00000000	.00000000
	-.00000023	-.00000160	-.00000004	.00000000	.00000000
	.02194865	.18631698	-.00272426	-.00019847	.00002462
	.00000000	.00000000	.00000000	.00000000	.00000000
	-9.56460894	-42.75674852	-.80834980	.03705656	-.00166779
c10, 5=	.00000000	.00000000	.00000000	.00000000	.00000000
	.00000000	.00000000	.00000000	.00000000	.00000000
	.00008392	.00000011	.00000009	.00000002	.00000928
	.00000000	.00000000	.00000000	.00000000	.00000000
	-.01815757	-.00001120	.00000478	-.00000352	.00006343
c10,10=	.00000001	.00000000	.00000000	.00000000	.00000000
	.00000000	.00000002	.00000000	.00000000	.00000000
	.00000000	.00000000	1043.99988453	.00000000	.00004843
	.00000000	.00000000	.00000000	1044.00000000	.00000000
	.00000000	.00000000	.00004843	.00000000	783.98915325
c10,15=	.00000001	.00000000	.00000000	.00000000	.00000000
	-.00000010	.00000000	.00000000	.00000000	.00000000
	.01400817	.00000000	.00000000	.00000000	.00000000
	.00000000	.00000000	.00000000	.00000000	.00000000
	4.91326452	.00000000	.00000000	.00000000	.00000000
c15, 0=	134.77992743	7597.49087735	552.02680004	-7.35789262	1.87318937
	.00000000	.00000000	.00000000	.00000000	.00000000
	.00000000	.00000000	.00000000	.00000000	.00000000
	.00000000	.00000000	.00000000	.00000000	.00000000
	.00000000	.00000000	.00000000	.00000000	.00000000
c15, 5=	4.17535045	.00081758	.00167917	.00070458	.02333736
	.00000000	.00000000	.00000000	.00000000	.00000000
	.00000000	.00000000	.00000000	.00000000	.00000000
	.00000000	.00000000	.00000000	.00000000	.00000000
	.00000000	.00000000	.00000000	.00000000	.00000000
c15,10=	.00000001	-.00000010	.01400817	.00000000	4.91326452
	.00000000	.00000000	.00000000	.00000000	.00000000
	.00000000	.00000000	.00000000	.00000000	.00000000
	.00000000	.00000000	.00000000	.00000000	.00000000
	.00000000	.00000000	.00000000	.00000000	.00000000

```
c15,15=2016554486.94951   .00000000      .00000000      .00000000      .00000000
           .00000000*************      .00000000      .00000000      .00000000
           .00000000      .00000000   64.00000000      .00000000      .00000000
           .00000000      .00000000      .00000000      .00000012      .00000000
           .00000000      .00000000      .00000000      .00000000      .00000012
       17561.7887126531957.85061527-4910.49622554   -37.49722976   -7.78953802
         20.09352349     -.00398928      .00261671     -.00124168
       31957.85061527************* -767.71081927 -191.36725735   18.82766081
        108.75099693     -.00051575      .00562734      .02449913
       -4910.49622554 -767.71081927 6267.54073034      4.05511133     5.84894255
         -1.65490022      .00371588     -.00111679     -.00007258
        -37.49722976 -191.36725735      4.05511133      .19375204     -.01285322
          -.10519123     -.00000560     -.00000446     -.00002866
         -7.78953802    18.82766081      5.84894255     -.01285322      .01344507
           .00773345      .00000260     -.00000068      .00000505
         20.09352349   108.75099693     -1.65490022     -.10519123      .00773345
           .06485597      .00000735      .00000193      .00001456
          -.00398928     -.00051575      .00371588     -.00000560      .00000260
           .00000735      .00000017      .00000001      .00000000
           .00261671      .00562734     -.00111679     -.00000446     -.00000068
           .00000193      .00000001      .00000026      .00000004
          -.00124168      .02449913     -.00007258     -.00002866      .00000505
           .00001456      .00000000      .00000004      .00000023
    (etc.)
```

Response to "trjattdat" type entry:

```
 opening trjattdata
 testing  attdat
 testing  aveX
 testing  beadat
 testing  differ
 testing  imu
 testing  msbls
 testing  obdata
```

```
 testing  raepos
 testing  rdrdata
 testing  table
 testing  taperdr
 testing  tape9
 testing  trjattdat

t =  564860.0000
pos. =          19182097.425         -2287947.404        -10503956.638
vel. =              3530.03959532        25054.96090202          1043.55551138
sens acc. =              -.00001154             .00006874            -.00008234
angluar pos. =       .00000000      .00000000      .00000000
angluar rate =       .00000000      .00000000      .00000000
angluar acc. =       .00000000      .00000000      .00000000
covar. =  189033.515787656240 343991.432630586150 -52856.140166800455
               -403.616812035953     -83.845887309623     216.284881491139
                   .000000000000        .000000000000        .000000000000
          343991.4326305861502193460.475505826500  -8263.570280253874
              -2059.859963839414     202.659249285784    1170.585959739241
                   .000000000000        .000000000000        .000000000000
          -52856.140166800455  -8263.570280253874  67463.245286879857
                 43.648853976990      62.957492120541     -17.813197280435
                   .000000000000        .000000000000        .000000000000
            -403.616812035953  -2059.859963839414     43.648853976990
                  2.085529548453      -.138350852837      -1.132268987972
                   .000000000000        .000000000000        .000000000000
             -83.845887309623   202.659249285784     62.957492120541
                  -.138350852837       .144721475520         .083242164527
                   .000000000000        .000000000000        .000000000000
             216.284881491139   1170.585959739241    -17.813197280435
                 -1.132268987972       .083242164527         .698103798751
                   .000000000000        .000000000000        .000000000000
               .000000000000        .000000000000        .000000000000
                   .000000000000        .000000000000        .000000000000
                   .000000413061        .000000000000        .000000000000
               .000000000000        .000000000000        .000000000000
```

```
                  .000000000000          .000000000000          .000000000000
                  .000000000000          .000000416163          .000000000000
              .000000000000          .000000000000          .000000000000
                  .000000000000          .000000000000          .000000000000
                  .000000000000          .000000000000          .000000410336
body cgs =          -56.08442             .03333          3.89167
primary imu code =       4
M50 to body transformation =        -.06049238       -.78694542       -.61405015
                   row two =        -.36984357        .58906148       -.71848613
                 row three =         .92712265        .18363956       -.32668043
m50 quaternian =      .5481534     .4114385    -.7028930     .1902304

t =  564861.0000

    (etc.)
```

38.2.3 Execution Procedure

Normal execution is accomplished by executing the program in the production directory containing the input file and insuring that the PATH accesses the /users/Adheaven/Utilities directory. Execution is accomplished by entering

readadata.x

Run time is variable depending on the length of the input file and the type of the input file. In most cases the run time is less than two minutes.

38.2.4 Messages

None.

39.0 RDRPOS

39.1 RDRPOS FUNCTIONAL DESCRIPTION

RDRPOS is a configured program but is not in the normal stream of programs for the Ascent/Descent process. The primary purpose of this program is to build files of ECI/UVW position data in order to compare radars with each other. The program accepts raw radar data from the RDRDATA file, unblocks the earth fixed data and converts to ECI coordinates, and stores the ECI position data into the RADRPOS(i) files. The OBDATA file is converted to ECI position and saved in a similar file, ONBORDPOS. Also, the OBDATA file is converted to UVW position and saved in a file UVWPOS. These files are used in STATCOM to generate differences of any station or onboard data. Some special analysis files are generated along with the ECI files. RDRPOS66 contains a print summary of the spacecraft elevation including low elevation flag in addition to identifying range, azimuth, and elevation starts and stops. The functions performed by the program are as follows:

(1) Read the radar station data and the RNP matrix.

(2) Convert the radar station position coordinates to an ECI transformation matrix.

(3) Read the raw radar file, RDRDATA, and unblock the data; convert the position denoted by range, azimuth and elevation to ECI cordinates and save blocked data in individual radar files (RADRPOS(i)).

(4) Scan the radar station data as it converts it to generate a file of basic information of that station (eg., start/stop times, deletion intervals, intervals below 3 degrees, etc.).

(5) Read the OBDATA file and convert the Mean-of-50 coordinates to ECI coordinates and UVW coordinates.

(6) Generate a file of the radar stations available for QA processing.

39.2 RDRPOS OPERATIONAL DESCRIPTION

The executable configured code is in /users/Adheaven/EXECUTE. A normal setup of the flight production directory will move a copy of the executable code to the production directory. RDRDATA, generated from a successful execution of UN2HP using the radar data tape, must be in the directory. INPUT must be executed to generate RDRPOS.IN. A successful execution of UN2HP using the onboard state trajectory data will generate OBDATA. The quality assurance output file is RDRPOS66. The primary output files are RADRPOS(i) for the blocked radar data for each radar station and ONBORDPOS and UVWPOS for the OBDATA trajectory. STATIONIDS is a byproduct quality assurance file.

39.2.1 Equipment Configuration

No special configuration is required to execute RDRPOS.

39.2.2 Input Items

The files required for execution are RDRDATA, OBDATA, and RDRPOS.IN.

RDRPOS.IN

RDRPOS.IN is a binary file generated from a succesful execution of the program INPUT.

RDRDATA

The file RDRDATA is a binary file generated from a UN2HP execution using the raw radar tape as an input.

OBDATA

The file OBDATA is a binary file generated from a UN2HP execution using the raw state vector tape as an input.

39.2.2.2 Definition of Inputs

RDRPOS.IN

RDRPOS.IN is a binary file and is used as an input file for RDRPOS. It is composed of two arrays and a number in one record arranged as follows:

(1) P array (double precision) (540) - The p array for the LRBET5 filter.

(2) PS array (double precision) (372) - the ps array contains the radar station data for the LRBET5 filter.

(3) number of days (double precision) - The number of days since dec 31 (eg., Jan 12 is 12).

RDRDATA

RDRDATA is a file of blocked identical numerical records with one header record. The blocking factor is 125 numerical records. The header record is 81 characters and is not used for any purpose. Each new radar station will begin a new block. When data ends for a radar station before a block ends, the rest of the block is filled with -9999.d0 for every word in the record. Each record has the following data in the order listed:

(1) record count (double precision) - the record number in the block (1-125)

(2) station ID number (double precision) - the TRWID number of the radar

station. Numbers under 100 are high rate (tenth second data) stations. Stations over 100 are low rate stations and are normally S-band stations. It is possible to get high rate and low rate data from the same station on this file.

(3) time (double precision) - the time tag of the data on the record. The data is time tagged in seconds from midnight the day of launch.

(4) range (double precision) - the range measurement for that time interval. Data is measured in feet.

(5) elevation or X angle (double precision) - this measurement is an angle measurement. Elevation is measured on all C-band stations; X angle of the keyhole measurement for all S-band stations. Measurements are in radians.

(6) azimuth or Y angle (double precision) - this measurement is an angle measurement. Azimuth is measured on all C-band stations; Y angle of the keyhole measurement for all S-band stations. Measurements are in radians.

(7) Doppler counts (double precision) - this measurement is the Doppler counts for the S-band stations; it has no value for a C-band station. The measurement is dimensionless.

(8) station frequency (double precision) - this measurement contains the frequency of the S-band stations and is undefined for the C-band stations. The data is not used.

OBDATA

OBDATA is a file of identical records that are in the following order:

(1) dummy (integer) - not used.

(2) dummy (double precision) - not used.

(3) time (double precision) - time of the record in seconds from midnight December 31 of the previous year.

(4) state vector (6 values) (double precision) - in order, X,Y,Z position, and $\dot{X},\dot{Y},\dot{Z}$ velocity. Position data is in feet; velocity data is in feet/second.

39.2.3 Execution Procedure

Normal entry to a production directory(ie., login to Adprodct) will establish the correct PATH for executing RDRPOS. Execution is accomplished by entering

```
rdrpos.x
```

Run time is approximately 8 minutes depending on other users.

39.2.3.1 Sample Output

RDRPOS66

The following is a abbrieveated sample of the formatted debug file, RDRPOS66:

```
elevation data for station gdxs     7
aos at  568192.70    elevation at aos is   4.14
maximum elevation is   8.35
elevation went below three degrees at  568629.30
los at  568707.90    elevation at los is   2.69

elevation data for station vdbc    22
aos at  568062.30    elevation at aos is   7.11
maximum elevation is  41.05
elevation went below three degrees at  568727.70
los at  568802.00    elevation at los is   2.74
```

elevation data for station kptc 29
aos at 567151.40 elevation at aos is -7.12
maximum elevation is 1.43
los at 567483.50 elevation at los is -.54

elevation data for station frcc 37
aos at 568015.70 elevation at aos is .92
elevation went above three degrees at 568180.60
maximum elevation is 49.43
elevation went below three degrees at 568701.70
los at 568734.90 elevation at los is -1.62

STATIONIDS

The following is a sample of the file, STATIONIDS:

1 7 22 23 29 37 39 40 7 8 0 0 0 0 0 0 0 0 0 0

39.2.3.2 Definition of Outputs

RADRPOS(i)

RADRPOS(i) are files of blocked identical numerical records with no header records. The blocking factor is 125 numerical records. Each file will begin a new radar station in a new block. When data ends on a radar station before a block ends, the rest of the block is filled with -9999.d0 for every word in the record. Each record has the following data in the order listed:

(1) Time (double precision) - The time tag of the record and position data.

(2) X position (ECI) (double precision) - The X value of the position in ECI coordinates measured in meters.

(3) Y position (ECI) (double precision) - The Y value of the position in ECI coordinates measured in meters.

(4) Z position (ECI) (double precision) - The Z value of the position in ECI coordinates measured in meters.

(5) elevation (double precision) - The elevation angle of the radar station to the spacecraft corrected for refraction measured in radians.

ONBORDPOS

ONBORDPOS is a file of blocked identical numerical records with no header records. The blocking factor is 125 numerical records. When the block ends, the rest of the block is filled with -9999.d0 for every word in the record. Each record has the following data in the order listed:

(1) Time (double precision) - The time tag of the record and position data.

(2) X position (ECI) (double precision) - The X value of the position in ECI coordinates measured in meters.

(3) Y position (ECI) (double precision) - The Y value of the position in ECI coordinates measured in meters.

(4) Z position (ECI) (double precision) - The Z value of the position in ECI coordinates measured in meters.

(5) elevation (double precision) - This variable has no meaning in the ONBORDPOS file. A dummy number is assigned to this variable to keep the file similar to the radar station files.

UVWPOS

UVWPOS is a file of blocked identical numerical records. The blocking factor is 125 records per block. When the data ends, the remainder of the block is filled with -9999.d0. Each record has the following data in the order listed:

(1) Time (double precision) - The time tag of the UVW transformation matrix.

(2) U unit vector (double precision) (3) - The three components of the unit vector that identify the U direction in the Mean-of-50 coordinates.

(3) V unit vector (double precision) (3) - The three components of the unit vector that identify the V direction in the Mean-of-50 coordinates.

(4) W unit vector (double precision) (3) - The three components of the unit vector that identify the W direction in the Mean-of-50 coordinates.

39.2.4 Messages

None.

40.0 RUNBEA

40.1 RUNBEA FUNCTIONAL DESCRIPTION

This program is not interactive. The purpose of this program is to review the three IMU quaternion data sets, evaluate the best quaternion set for the interval, and generate a file using the best available quaternion. The following specific functions are accomplished by RUNBEA:

(1) Read and transform the refsmats to quaternions.

(2) Read the user selected options for the quaternions and the tolerances on the values.

(3) Generate the heading for the formatted debug file containing the selected criteria for the quaternion determination.

(4) Initialize the quaternion selection option and tolerance levels.

(5) Select the best quaternion to use for the output based on user criteria, data availability, and quaternion normalization/tolerance evaluation.

(6) Transform the stable member to outer roll quaternion to a Mean-of-50 roll quaternion.

(7) Output the best quaternion with the selection criteria (user and program selection).

40.2 RUNBEA OPERATIONAL DESCRIPTION

RUNBEA is one of the Ascent/Descent configured programs and resides in /users/Adheaven/EXECUTE. The program requires that TELMTR must have been successfully executed generating the file, ATTDATA. The file RUNBEA.IN generated from a successful completion of INPUT must be in the production directory. The program generates two files, BEADATA and RUNBEA66. BEADATA is the primary output data file. RUNBEA66 is a formatted debug file and the output is selectable by setting a debug flag in the INPUT menu RARELY CHANGED VARIABLES. The file may have minimal data or may be an augmented full copy of the file BEADATA in formatted form. BEADATA is one of the primary input files to MERGE.

40.2.1 Equipment Configuration

The program must be executed in the directory where the input files are located. The input files are ATTDATA and RUNBEA.IN. Output files will be generated in the directory of execution.

40.2.2 Input Items

Input consists of the two files, RUNBEA.IN and ATTDATA.

RUNBEA.IN

RUNBEA.IN is a binary file and is used as an input file for RUNBEA. It contains two records of the following variables in the following order:

(1) Record 1 has the refsmats for the three IMU's as follows:

   (a) IMU1 refsmat (double precision) (3,3) - The IMU1 refsmat in column major order.

   (b) IMU2 refsmat (double precision) (3,3) - The IMU2 refsmat in column major order.

   (c) IMU3 refsmat (double precision) (3,3) - The IMU3 refsmat in column major order.

(2) Record 2 has eleven elements described as follows:

(a) number of breakpoints (integer) - The number of specific array points in the breakpoint dependent arrays.

(b) breakpoint times (double precision) (50) - The times identified where changes in IMU selection option changes or tolerance value changes are required. Time is in seconds from day of launch.

(c) iopt (integer) (51) - Options selected for each matching time interval for IMU quaternion selection criteria.

(d) start time (double precision) - time in seconds of the start of the mission based on midnight day of launch.

(e) stop time (double precision) - time in seconds of the stop of the mission based on midnight day of launch.

(f) default value (double precision) - The default value passed to the program RUNBEA (normally -9999.d0).

(g) breakpoint tolerances (double precision) (51) - Tolerances for each matching time interval for IMU quaternion selection/deletion criteria.

(h) qrolsm1 (double precision) (4) - quaternion defining the stable member to outer roll gimbal transformation for IMU1.

(i) qrolsm2 (double precision) (4) - quaternion defining the stable member to outer roll gimbal transformation for IMU2.

(j) qrolsm3 (double precision) (4) - quaternion defining the stable member to outer roll gimbal transformation for IMU3.

(k) print flag (logical) - logical print flag to print the full print file similar to the binary output file from RUNBEA. True is to print the file; false is not to print the file.

ATTDATA

This file is a binary file used as an input file to RUNBEA. It consists of multiple records with the following order for the thirteen double precision words:

(1) time of the quaternion measurement in seconds from midnight day of launch.

(2) first component of IMU1 stable member to outer roll quaternion.

(3) second component of IMU1 stable member to outer roll quaternion.

(4) third component of IMU1 stable member to outer roll quaternion.

(5) fourth component of IMU1 stable member to outer roll quaternion.

(6) first component of IMU2 stable member to outer roll quaternion.

(7) second component of IMU2 stable member to outer roll quaternion.

(8) third component of IMU2 stable member to outer roll quaternion.

(9) fourth component of IMU2 stable member to outer roll quaternion.

(10) first component of IMU3 stable member to outer roll quaternion.

(11) second component of IMU3 stable member to outer roll quaternion.

(12) third component of IMU3 stable member to outer roll quaternion.

(13) fourth component of IMU3 stable member to outer roll quaternion.

40.2.3 Execution Procedure

Normal setup of the production directory will copy the current version of the executable RUNBEA program. Execution is accomplished by entering and executing

runbea.x

Runtime is approximately 2 minutes.

40.2.3.1 Sample Output

RUNBEA66

The following is a sample of RUNBEA66 when the debug flag is set off:

```
 lear record count=    0
```

The following is a shortened sample of RUNBEA66 when the debug flag is set on:

```
                              best estimate of attitude

the timepoints separating options are

           567000.000

the options are
                     7
                     7
the start time for processing is
           564860.000
the stop time for processing is
           568800.000
```

the default value is

-9999.000

the tolerances are

.050

.050

time	op	s	u or d	d12	d13	d23	d11	d22	d33	qd	q1	q2	q3	q4
564860.9	7	6	ddu	.210	.183	.126	-99.	-99.	-99.	-99.	.548	.411	-.702	.190
564861.8	7	6	ddu	.211	.180	.132	.026	.035	.029	.029	.548	.411	-.702	.190
564862.8	7	6	ddu	.208	.179	.121	.036	.030	.044	.044	.547	.412	-.702	.190
564863.8	7	6	ddu	.210	.176	.122	.031	.033	.034	.034	.547	.412	-.702	.190
564864.7	7	6	ddu	.209	.184	.125	.039	.037	.036	.036	.547	.412	-.702	.190
564865.7	7	6	ddu	.208	.182	.116	.041	.032	.037	.037	.547	.412	-.702	.190
564866.6	7	6	ddu	.205	.175	.117	.031	.037	.036	.036	.546	.413	-.702	.190

--- (etc., For the rest of the time intervals) ---

568796.9	7	5	dud	.124	.162	.087	.004	.010	.008	.010	.360	-.228	-.849	-.310
568797.8	7	5	dud	.110	.158	.083	.005	.011	.006	.011	.360	-.228	-.849	-.310
568798.8	7	5	dud	.116	.165	.087	.005	.004	.006	.004	.360	-.228	-.849	-.310
568799.8	7	5	dud	.121	.172	.094	.012	.012	.006	.012	.360	-.228	-.849	-.310

lear record count= 0

where the elements across each line have the following meanings:

(1) time of the measurment in seconds.

(2) The user option(op) selection as defined below:

1 -- IMU 1 prime select option
2 -- IMU 2 prime select option
3 -- IMU 1 and imu 2 average option
4 -- IMU 3 prime select option
5 -- IMU 1 and imu 3 average option
6 -- IMU 2 and imu 3 average option
7 -- average all three or program select best

(3) The quaternion selection(s) as made by the program as defined below:

0 -- correct operation of option
1 -- average q1 and q2, option 7, all IMUs available
2 -- average q1 and q3, option 7, all IMUs available
3 -- average q2 and q3, option 7, all IMUs available
4 -- mid quat select IMU 1
5 -- mid quat select IMU 2
6 -- mid quat select IMU 3
7 -- quaternion needed but not available, all options
11 -- only q1,q2 available, average, option 7
12 -- only q1,q3 available, average, option 7
13 -- only q2,q3 available, average, option 7
14 -- only q1 available, options 3,5,7
15 -- only q2 available, options 3,6,7
16 -- only q3 available, options 5,6,7

(4) The actual usage(u or d) of the quaternion as follows:

"u" -- if quaternion was used in the solution
"d" -- if quaternion was available but not used in the solution
" " -- if quaternion was not available

(5) The next three items(d12, d13, d23) are the differences in the quaternions at the same time (ie., quaternion 1 minus 2 is q12) measured in degrees with 3 decimals.

(6) The next four items(d11, d22, d33, qd) are the differences in the quaternions at consecutive times (ie., quaternion 1 now minus quaternion 1 previous is q11, where qd is the best estimate) measured in degrees with 3 decimals.

(7) The last four entries(q1, q2, q3, q4) are the best estimate quaternion as decided by the program. The units are radians and there are 6 decimals in the printout.

40.2.3.2 Definition of Outputs

BEADATA

BEADATA is the primary binary output to RUNBEA. It is composed of multiple records in the following format:

(1) Time (double precision) - The time of the stable member to roll quaternion in seconds from midnight day of launch.

(2) IOPTV (integer) - User option selection currently in use at this time. (See item 2 above)

(3) ISTAT (integer) - Selected status of the best estimate quaternion. (See item 4 above)

(4) BEQ (double precision) (4) - The Best Estimate Quaternion estimating the transformation from Mean-of-50 to body axis coordinates measured in radians in standard quaternion definition(scalar, vector (x,y,z)).

40.2.4 Messages

There are no messages sent to the screen however the following error message can be sent to the debug print when the debug print is ON:

xxxxxx.x prime sl. quat not avail

This error message will occur when the program detects that the user selected IMU quaternion is not available. If the program is selecting the prime quaternion, then this message will occur when all three IMU quaternions are not in the data stream (ie., all default data).

41.0 SPLINE

41.1 SPLINE FUNCTIONAL DESCRIPTION

This program is not interactive. The purpose of this program is to fit a cubic spline curve through the LRBET5 trajectory state values and then compare it with the OBDATA trajectory state. The differences in U,V,W position and velocity are saved for later plotting using QASPLINE. The following specific functions are accomplished by SPLINE:

(1) Open the LRBET5 trajectory data file and calculates a cubic spline through the data.

(2) Save the spline trajectory in a direct access files.

(3) Scan the OBDATA until the times of the start of the spline trajectory match.

(4) Interpolate the spline data as necessary to match the time of the OBDATA states.

(5) Compute the difference between the spline and onboard trajectories in UVW coordinates(downrange, crossrange and vertical).

(6) Clip the maximum differences at 3400 meters for position differences and 4 meters per second for velocity differences.

(7) Save the difference in position and velocity in a binary output file.

(8) Close the output files and destroys the scratch direct access files.

41.2 SPLINE OPERATIONAL DESCRIPTION

SPLINE is one of the Ascent/Descent configured programs and resides in

/users/Adheaven/EXECUTE. The program requires that LRBET5 must have generated a TAPE9 file. The program is intended to accept a forward/backward filter run but can also be used with a forward only filter run. The program requires a successful completion of UN2HP using the onboard data tape generating the file, OBDATA. The program, INPUT, must have been executed generating the file, SPLINE.IN. The output files are SPLINE66, a formatted debug file, and SPLINEPLT, a binary output file of the position/velocity differences.

41.2.1 Equipment Configuration

The standard Ascent/Descent equipment configuration is required.

41.2.2 Input Items

SPLINE.IN

SPLINE.IN is a binary file and is used as an input file for SPLINE. It contains one record of the following variables in the following order:

(1) start time (double precision) - time in seconds of the start of the mission based on midnight day of launch.

(2) stop time (double precision) - time in seconds of the stop of the mission based on midnight day of launch.

(3) number of days (double precision) - The number of days since dec 31 (ie., day of the year) to launch day.

TAPE9

TAPE9 is the primary output of the LRBET5 process. This file contains the LRBET5 output products consisting of identical records with ordered elements as defined below:

(1) time (double precision) - this is the time of the state vector measured in seconds from midnight of the day of launch.

(2) state vector (20) (double precision) - this is an array of the filter calculated state vector with (1-3) position components (X,Y,Z) in mean of 50 coordinates measured in meters; (4-6) velocity components ($\dot{X},\dot{Y},\dot{Z}$) in mean of 50 coordinates measured in meters/second; (7-9) imu misalignment of the X,Y,Z components in mean of 50 coordinates measured in radians; (10) C-band1 range bias measured in meters; (11) C-band1 azimuth bias measured in radians; (12) C-band1 elevation bias measured in radians; (13) C-band2 range bias measured in meters; (14) C-band3 range bias measured in meters; (15) S-band range bias measured in meters; (16) S-band Doppler integration constant measured in meters; (17) S-band Doppler integration constant measured in cycles; (18) MSBLS range bias measured in meters; (19) MSBLS azimuth bias measured in radians; (20) MSBLS wedge angle bias measured in radians.

(3) sensed acceleration (3) (double precision) - the sensed acceleration components ($\ddot{X},\ddot{Y},\ddot{Z}$) as calculated by the filter in mean of 50 coordinates and measured in meters per second squared.

(4) covariance matrix (20x20) (double precision) - the state vector covariance matrix as defined by (2) above.

(5) total acceleration(3) (double precision) - the totaled acceleration components ($\ddot{X},\ddot{Y},\ddot{Z}$) as calculated by the filter and modified by gravity in mean of 50 coordinates and measured in meters per second squared.

(6) TDRSS components(25) (double precision) - 25 TDRSS components that are not used by any program to date.

OBDATA

OBDATA is a file of identical numerical records with three header records that are not used. The numerical records are in the following order and represent the variables indicated:

(1) dummy (integer) - not used.

(2) dummy (double precision) - not used.

(3) time (double precision) - time of the record in seconds from midnight December 31 of the previous year.

(4) state vector (6 values) (double precision) - in order (X,Y,Z) position and ($\dot{X},\dot{Y},\dot{Z}$) velocity. Position data is in feet; velocity data is in feet/second.

41.2.3 Execution Procedure

Normal setup of the production directory will copy the current version of the executable SPLINE program. Execution is accomplished by entering

spline.x

Runtime is approximately 6 minutes.

41.2.3.1 Sample Output

SPLINE66

The following is a abbreviated sample of the file, SPLINE66:

time	u	v	w	udot	vdot	wdot
564860.25	412.72	-1100.80	76.72	.83	-.50	.01
564861.21	411.82	-1101.75	76.72	.83	-.51	.00
564862.17	411.52	-1102.69	76.73	.84	-.50	.01

(etc., For each time in the OBDATA file as required)

568786.17	-5.24	29.71	24.26	-.13	.00	-.02
568787.13	-5.36	29.76	24.15	-.13	.00	-.04
568788.09	-5.54	30.09	23.98	-.13	.00	-.06
568789.21	-5.68	30.20	23.88	-.13	.10	.01

41.2.3.2 Definition of Outputs

SPLINEPLT

SPLINEPLT is the primary binary output file used for plotting the differences. It is composed of multiple identical records of the following format and values:

(1) Time (double precision) - The time of the difference calculation based on the OBDATA timing. The time is in seconds from midnight day of launch.

(2) Vertical Position difference (double precision) - The difference in meters of the two positions in the vertical direction.

(3) Downrange Position difference (double precision) - The difference in meters of the two positions in the downrange direction.

(4) Crossrange Position difference (double precision) - The difference in meters of the two positions in the crossrange direction.

(5) Vertical Velocity difference (double precision) - The difference in

meters/second of the two velocities in the vertical direction.

(6) Downrange Velocity difference (double precision) - The difference in meters/second of the two velocities in the downrange direction.

(7) Crossrange Velocity difference (double precision) - The difference in meters/second of the two velocities in the crossrange direction.

41.2.4 Messages

There are no messages sent to the screen, however the following error messages can be sent to the formatted file SPLINE66 when applicable:

" eof encountered during search for initial onboard record
onboard time = xxxxxxx.xx bet time = xxxxxxx.xx"

This message will occur if the OBDATA file is searched and the start time of the mission is not found. Possible errors could be no OBDATA file present in the production directory or the SPLINE.IN (ndays) is incorrect.

" end of file encountered on onboard tape"

This message will occur when the onboard file ends before the LRBET5 trajectory ends or the mission stop time is not reached.

" eof encountered during search for first record
start = xxxxxx.xxt = xxxxxx.xx"

This message will occur when the TAPE9 file is not present.

" end of file encountered during forward pass
tstop = xxxxxx.xxt = xxxxxx.xx"

This message will occur when the TAPE9 end of file is reached before the stop time of the mission.

42.0 STATCOM

42.1 STATCOM FUNCTIONAL DESCRIPTION

STATCOM is a configured program but is not in the normal stream of programs of the Ascent/Descent process. The primary purpose of this program is to plot the differences of the radar to radar comparisons. The program also will plot the onboard position data against each radar determined position as a baseline. The program is interactive and requires answering questions and inserting the numbers of the radar stations to plot. The functions performed are as follows:

(1) Initialize the radar station array of available stations.

(2) Read the special events to identify on the plots.

(3) Request the plots desired from the user.

(4) Find the common data in both radar station files.

(5) Calculate the difference between the two stations at a common time and save the difference.

(6) Generate a plot of the difference in positions for the designated radar stations.

(7) Scale the time vs difference in position plot automatically in seconds vs meters.

42.2 STATCOM OPERATIONAL DESCRIPTION

The executable code is configured in /users/Adheaven/EXECUTE. A normal setup of the flight production directory will load the executable code in the directory. The directory must contain the RADRPOS(i), ONBORDPOS, and

STATIONIDS files generated by a successful execution of RDRPOS. STATCOM.IN must be available from a successful execution of INPUT. No output files are generated however plots are output to the terminal internal printer.

42.2.1 Equipment Configuration

A HP terminal with an internal printer must be used with this program. Standard output codes for a HP2623 device are assumed.

42.2.2 Input Items

STATIONIDS

The following sample formatted input is read by the program the non-zero ID's determine the radar stations available for plotting:

```
 1  7 22 23 29 37 39 40  7  8  0  0  0  0  0  0  0  0  0  0
```

RADRPOS(i)

RADRPOS(i) are files of blocked identical numerical records with no header records. The blocking factor is 125 numerical records. Each file will begin a new radar station in a new block. When data ends on a radar station before a block ends, the rest of the block is filled with -9999.d0 for every word in the record. Each record has the following data in the order listed:

(1) Time (double precision) - The time tag of the record of the position data.

(2) X position (ECI) (double precision) - The X value of the position in ECI coordinates measured in meters.

(3) Y position (ECI) (double precision) - The Y value of the position in ECI coordinates measured in meters.

(4) Z position (ECI) (double precision) - The Z value of the position in ECI coordinates measured in meters.

(5) elevation (double precision) - The elevation angle of the radar station to the spacecraft corrected for refraction measured in radians.

ONBORDPOS

ONBORDPOS is a file of blocked identical numerical records with no header records. The blocking factor is 125 numerical records. When the data ends, the rest of the block is filled with -9999.d0 for every word in each record to the end of the block. Each record has the following data in the order listed:

(1) Time (double precision) - The time tag of the record of the position data.

(2) X position (ECI) (double precision) - The X value of the position in ECI coordinates measured in meters.

(3) Y position (ECI) (double precision) - The Y value of the position in ECI coordinates measured in meters.

(4) Z position (ECI) (double precision) - The Z value of the position in ECI coordinates measured in meters.

(5) elevation (double precision) - This variable has no meaning in the ONBORDPOS file. A dummy number is assigned to this variable to keep the file similar to the radar station files.

STATCOM.IN

STATCOM.IN is a binary file and is used as an input file for STATCOM. It contains multiple records of the following variables in the following order:

(1) Record 1 contains the integer number of special events to pass to the program STATCOM.

(2) Record 2 thru xx each contain two elements described as follows:

  (a) Special event name (10 characters) - The special character description of the event to appear on the plot(eg., MECO).

  (b) Special event time (double precision) - The time in seconds from midnight day of launch of the special event. The number of records depends on the numerical value of record #1.

42.2.3 Execution Procedure

Normal entry to a production directory(ie., login to Adproduct) will establish the correct PATH for executing STATCOM. execution is accomplished by entering

```
statcom.x
```

Run time is dependent on the user selection of plots. Since the program is interactive, questions for user desires are presented. The following is the series of questions presented to the user:

```
Choose one of the following options:

        1) compare the onboard with all radar stations
        2) make individual comparisons of radar stations
           enter 1 or 2
```

Selection of option one will generate a series of plots one after another without user activity until all of the radar stations have been plotted against the onboard data positions. This normally will generate 7 to 15 plots depending on the number of radar stations available on the mission. After all these plots are finished the following question will appear:

Do you wish to make some individual plots? (y/n)

An answer in the affirative will cause the program to respond as if a choice of option two of the previous question was made. An answer in the negative terminates the program.

Selection of option two will cause the program to respond with a series of questions as follows:

enter the numeric id of the first station

The program expects a station number that corresponds to one of the numbers in the STATIONIDS. This number is the TRWID of one of the radars on the mission and corresponds to one of the RADRPOS(i) files. After insertion of the radar station TRWID, the following question appears:

enter the numeric id of the second station

After selection of a valid second radar station number the following sample statements will appear:

radrpos3 opened
radrpos5 opened

At this point the program scans both radar data files to find common times and calculates the differences in position, then plots whatever data has been generated. If no data is on the plot then the program found no common times when both radars were tracking at the same time. After the plot is complete, the following message will appear:

do you wish to do it again? (y/n)

A selection in the affirmative will return to the questions about radar ID's. A negative response will terminate the program.

42.2.3.1 Sample Output

There are no printed outputs from this program; only plots to the terminal internal plotter.

42.2.4 Messages

The following error messages may occur in the process of executing the program:

(1) "These are the same stations. Try again, bozo!"

This message will occur when the user inserts the same number for both radar station numeric ID's. The program returns the questions about radar numeric ID's.

(2) "there is no data for station xx."

This message will occur when the user enters a radar station numeric ID that does not match one of the numeric ID's in the file STATIONIDS. The program will return to the questions about radar ID's.

(3) "xxx is an invalID station ID"

This message will occur when the user enters a negative number or zero for a station ID. The program will return to the questions about radar ID's.

43.0 TELMTR

43.1 TELMTR FUNCTIONAL DESCRIPTION

The program is not user interactive. It outputs up to six pre-designated output files. The program does six basic functions as described below:

(1) Unblock the telemetry data.

(2) Edit out erroneous IMU and quaternion data.

(3) Set up the quaternion file, ATTDATA (input to RUNBEA).

(4) Set up the IMU file, TAPE10 (input to LRBET5).

(5) Set up the IMU time files, IMUxDT (input to QAIMU).

(6) Set up the general purpose plotting file, QADATA1 (input to QAIMU).

43.2 TELMTR OPERATIONAL DESCRIPTION

The program is one of the Ascent/Descent configured programs. The user must generate the input file, TLMDATA, by executing the UN2HP program. The user must also generate the input file, TELMTR.IN, by executing the INPUT program. This program prepares the IMU data for input to the LRBET5 filter by unblocking the individual IMU data into a record containing all three IMUs ie. 9 data elements, 3 for each IMU. The program also prepares the quaternion data in the same manner for input to RUNBEA. The program prepares for the IMU QA function plotting routine, QAIMU, by setting up the IMU time files (IMUxDT) and the general input plotting file (QADATA1).

43.2.1 Equipment Configuration

The program must be executed in the directory where the input files are located. The input files are TLMDATA and TELMTR.IN. Output files will be generated in the directory where execution occurs.

43.2.2 Input Items

The two input files are binary files.

TLMDATA

This file is a blocked binary file. The file contains one header file that has nothing of value (81 integers each). The blocked data is blocked in records of 1000 double precision numbers. Within the blocked record are 100 sub-records of ten double precision numbers. That sub-record contains the IMU or quaternion data. Invalid data are marked by -9999.0 in the data. The items in the sub-record that are used are as follows in the order presented:

(1) measurement type 1,2,3 are correspondingly IMU1, IMU2, and IMU3; 4,5,6 are correspondingly quaternions from IMU1, IMU2, and IMU3.

(2,3) are not used by the program.

(4) time - the measurement time tag in seconds since midnight day of launch.

(5) not used by the program.

(6) x component of the IMU if measurement type (1,2,3) OR 1st component of the IMU quaternion if a measurement type (4,5,6).

(7) y component of the IMU if measurement type (1,2,3) OR 2nd component of of the IMU quaternion if a measurement type (4,5,6).

(8) z component of the IMU if measurement type (1,2,3) OR 3rd component of of the IMU quaternion if a measurement type (4,5,6).

(9) 4th component of the IMU quaternion if a measurement type (4,5,6).

(10) not used by the program.

TELMTR.IN

This file is binary and contains the following variables in the following order:

(1) start - the output data start time desired (time is in seconds from midnight day of launch,usually ten seconds prior to ignition for Ascent and ten seconds prior to deorbit burn for Descent) (double precision).

(2) stp - the output data stop time desired (time is in seconds from midnight day of launch, usually ten seconds after OMS2 cutoff for Ascent and ten seconds after all stop on the runway for Descent) (double precision).

(3) t1 - the time criteria to set the test in TELMTR on when to use the micro-g criteria, i.e., freeflight. For Ascent the time is MECO + ten seconds; for Descent the time is ten seconds prior to start time (double precision), seconds from midnight day of launch.

(4) t2 - The time criteria to set the test in TELMTR on when to use the high-g criteria, i.e., thrust/aerodrag. For Ascent the time is start time - ten seconds; for Descent the time is Entry Interface (400000ft) (double precision), seconds from midnight day of launch.

(5) offset - the time correction to convert onboard time to ground time (normally zero) (double precision), seconds.

(6) drftrt - the clock drift rate of the onboard clock (normally zero)

(double precision), seconds.

(7) reftm - the reference time used with the drift rate to calculate the time correction to be used (normally zero) (double precision), seconds from midnight day of launch.

43.2.3 Execution Procedure

Normal setup of a production directory will copy the current version of TELMTR into the production directory. Execution is accomplished by entering "telmtr.x". Run time is approximately 4 minutes.

43.2.3.1 Sample Output

TELMTR66

The sample output formatted file TELMTR66 is as follows:

```
 telmtr
   2874 IMU observations used      4 partial IMU observations  rejected
TIME    IMUX1   IMUY1   IMUZ1   IMUX2   IMUY2   IMUZ2   IMUX3   IMUY3   IMUZ3
       (here a list of deleted IMU measurements is presented)

 Number of IMU deletions was    0.
 Number of IMU component changes was    0.
  total number of record read in -->  2874
 total number of record written -->  2874
  total number of record read in -->  2875
 total number of record written -->  2875
  total number of record read in -->  2874
 total number of record written -->  2874
```

List of QUARTERNIONS that have been replaced by -9999 .0d0

TIME TAG	S	A	B	C	RSS	QUAT NUM
42925.8453	-.8389	.0000	.0000	.0000	.8389	2
42925.8453	.0000	.0000	.3678	-.1766	.4080	3
42944.0853	-.8681	.0000	.0000	.0000	.8681	2
42944.0853	.0000	.0000	.4197	-.1653	.4510	3
	-- etc. --					
45370.0053	.1397	.0000	.0000	.0000	.1397	2
45370.0053	.0000	.0000	.4489	.3689	.5810	3
45533.2053	.8158	-.0135	.0000	.0000	.8159	3

TAPE10

This file is a binary file suitable to use as the input file for LRBET5. The start time of the data is as defined by start time in TELMTR.IN. The stop time of the data is as defined by stop time in TELMTR.IN. The final two times in the file are 1.0d38 to flag the end of the file to LRBET5. It consists of records with the following order for the eleven double precision words:

(1) Time of the IMU measurement in seconds from midnight day of launch.

(2) Delta time, the difference in time from the last measurement to the current measurement.

(3) X component of sensed acceleration for IMU1 (in m/sec/sec).

(4) Y component of sensed acceleration for IMU1 (in m/sec/sec).

(5) Z component of sensed acceleration for IMU1 (in m/sec/sec).

(6) X component of sensed acceleration for IMU2 (in m/sec/sec).

(7) Y component of sensed acceleration for IMU2 (in m/sec/sec).

(8) Z component of sensed acceleration for IMU2 (in m/sec/sec).

(9) X component of sensed acceleration for IMU3 (in m/sec/sec).

(10) Y component of sensed acceleration for IMU3 (in m/sec/sec).

(11) Z component of sensed acceleration for IMU3 (in m/sec/sec).

IMUxDT

These three files are binary files for each IMU (x is substituted by 1,2,or3 to designate which IMU). These files are part of the input to the plotting routine, QAIMU. Each file has two double precision words in the same order as defined as follows:

(1) Time of the IMU measurement in seconds from midnight day of launch.

(2) Delta time, the difference in time from the last measurement to the current measurement.

ATTDATA

This file is a binary file suitable to use as an input file to RUNBEA. The start and stop times of the file are defined by the start and stop times inserted into TELMTR.IN. It consists of records with the following order for the thirteen double precision words:

(1) time of the quaternion measurement in seconds from midnight day of launch.

(2) first component of IMU1 quaternion.

(3) second component of IMU1 quaternion.

(4) third component of IMU1 quaternion.

(5) fourth component of IMU1 quaternion.

(6) first component of IMU2 quaternion.

(7) second component of IMU2 quaternion.

(8) third component of IMU2 quaternion.

(9) fourth component of IMU2 quaternion.

(10) first component of IMU3 quaternion.

(11) second component of IMU3 quaternion.

(12) third component of IMU3 quaternion.

(13) fourth component of IMU3 quaternion.

QADATA1

This file is a binary file suitable to use as an input file to QAIMU. The first record is an ASCII set that states 'opening QAdata1'. The remaining records are in the following order for the thirteen double precision words:

(1) Time of the IMU measurement in seconds from midnight day of launch.

(2) The difference between IMU1 X component and IMU2 X component at the given time (1).

(3) The difference between IMU1 X component and IMU3 X component at the given time (1).

(4) The difference between IMU2 X component and IMU3 X component at the

given time (1).

(5) The difference between IMU1 Y component and IMU2 Y component at the given time (1).

(6) The difference between IMU1 Y component and IMU3 Y component at the given time (1).

(7) The difference between IMU2 Y component and IMU3 Y component at the given time (1).

(8) The difference between IMU1 Z component and IMU2 Z component at the given time (1).

(9) The difference between IMU1 Z component and IMU3 Z component at the given time (1).

(10) The difference between IMU2 Z component and IMU3 Z component at the given time (1).

(11) The difference between the RSS value of IMU1 at this time (1) and the RSS value of IMU1 at the previous time.

(12) The difference between the RSS value of IMU2 at this time (1) and the RSS value of IMU2 at the previous time.

(13) The difference between the RSS value of IMU3 at this time (1) and the RSS value of IMU3 at the previous time.

TELMTR66

This output file is a formatted file that documents the actions accomplished in the running of TELMTR. Output is as defined in the sample output 43.2.3.1.

43.2.4 Messages

Normal Messages To The Screen

This message provides the user with immediate results of the automatic edit process. Deletions are the number of occurances where all of the IMU's at a particular time were incorrect. Component changes are the individual number of IMU components that were averaged or substituted for. The prompts sent to the screen in the process of executing TELMTR are:

```
Automatic EDIT IMU Program -- Version 3.000 1 July 86

Number of IMU deletions was
                  xxx
Number of IMU component changes was
                  xxx
Automatic Edit IMU Program -- Normal Termination
```

Abnormal Messages

Abnormal Messages Sent To The Screen

The following message is sent to the screen when an error occurs while reading TAPE10 as an intermediate input to the plotting file generation.

```
Error occured while reading the input file
Abnormal termination - Try again
```

Abnormal Messages Sent To The TELMTR66 File

The following error message is sent to the TELMTR66 file when editing the quaternions and it is difficult to define an initial set of quaternions.

the first xx quats are no good for IMU xx

44.0 UN2HP

44.1 UN2HP FUNCTIONAL DESCRIPTION

This program is interactive. The purpose of this program is to read the input tapes from the UNIVAC and convert and store the data in HP compatable files. The program is used to generate files that look identical to the UNIVAC files except that they are in HP format. The functions of the program are as follows:

(1) Request and read the output file name.

(2) Request and read the tape drive used as the input unit where the input tape is located.

(3) Request and read the number of header records on the tape.

(4) Read and save the header records in HP format.

(5) Read, convert, and save the data records in the desired output file.

(6) Present the number of records read at the end of the save process.

(7) Present the maximum and minimum size record of all the records saved.

44.2 UN2HP OPERATIONAL DESCRIPTION

UN2HP is one of the Ascent/Descent configured programs and resides in /users/Adheaven/EXECUTE. The program is used to read the input tapes from the UNIVAC for the input files, TLMDATA, RDRDATA, and OBDATA. The input for this program is a UNIVAC formatted tape on one of the tape drives. At execution time, the output file is determined by user entry to the program depending on the type of tape mounted. The interactive requests set up the correct output file and reading of the tape converts the data to HP format.

44.2.1 Equipment Configuration

The HP9000 needs a 1600 BPI tape drive attached to execute this program. The program should be executed in the production directory. Output files will be generated in the directory of execution.

44.2.2 Input Items

The input tape must be a UNIVAC tape containing one of the input data files. The three files used by this program are the radar data tape, the onboard data tape containing the onboard position data, and the telemetry data tape containing the IMU and Quaternian telemetry data. Format of these tapes conforms to the output data files as identified below.

44.2.3 Execution Procedure

Normal setup of the production directory will copy the current version of the executable UN2HP program. Execution is accomplished by entering

"un2hp.x"

The program will respond with the following request:

    "ENTER OUTPUT FILE NAME"

The expected response is one of three output files, TLMDATA, OBDATA, or RDRDATA. Any response may be made at this point since no checking of a correct response is attempted by the program. Any other output file name complicates the later actions in the production directory and is not recommended. After the output file name is read, the program presents the following request:

"ENTER INPUT TAPE UNIT (0 OR 1)"

The expected response is a "1" or a "0", however, any number may be entered. No verification is made at this time of the truth of the entry. The HP9000 has been set up in a configuration with two tape drives numbered "1" and "0". The operating system selects the correct tape drive and connects it to the unit of the FORTAN program. After the tape drive number has been read, the program presents the following request:

"ENTER NO. OF HEADER RECORDS ON TAPE"

The input tapes differ in the number of header records. TLMDATA and RDRDATA both have one header record; OBDATA has three header records. The user should enter the appropriate number of header records. At this time, the program begins to read the tape, convert the UNIVAC data to HP format, and saves the data in the output file entered by the user.

44.2.3.1 Sample Output

The output files are all binary, and only one of the following files will be output for a single execution.

TLMDATA (If the input tape is the telemetry data tape)

TLMDATA is a blocked binary file. The file contains one header record that has nothing of value (81 integers). The blocked data is blocked in records of 1000 double precision numbers. Within the blocked record are 100 sub-records of ten double precision numbers. That sub-record contains the IMU or quaternion data. Invalid data are marked by -9999.0 in the data. The items in the sub-record that are used are as follows in the order presented:

(1) measurement type 1,2,3 are, correspondingly, IMU1, IMU2; and IMU3; 4,5,6 are, correspondingly, quaternians from IMU1, IMU2, and IMU3.

(2,3) are not used in the program.

(4) time - the measurement time tag in seconds since midnight day of launch.

(5) not used by the program.

(6) x component of the IMU if measurement type (1,2,3) OR 1st component of the IMU quaternion if a measurement type (4,5,6).

(7) y component of the IMU if measurement type (1,2,3) OR 2nd component of the IMU quaternion if a measurement type (4,5,6).

(8) z component of the IMU if measurement type (1,2,3) OR 3rd component of the IMU quaternion if a measurement type (4,5,6).

(9) 4th component of the IMU quaternion if a measurement type (4,5,6).

(10) not used by the program.

OBDATA (If the input tape is the onboard data tape)

OBDATA has three header records that are not used in any of the Ascent/Descent programs. After the header records, the file consists of identical records that are in the following order and represent the variables indicated:

(1) dummy (integer) - not used.

(2) dummy (double precision) - not used.

(3) time (double precision) - time of the record in seconds from midnight December 31 of the previous year.

(4) state vector (6 values) (double precision) - in order, X, Y, Z position, and $\dot{X}$, $\dot{Y}$, $\dot{Z}$ velocity. Position data is in feet; velocity data is in feet/second.

RDRDATA (If the input tape is the radar data tape)

RDRDATA is a file of blocked identical numerical records with one header record. the blocking factor is 125 numerical records. The header record is 81 characters and is not used. Each new radar station will begin a new block. When data ends on a radar station before a block ends, the rest of the block is filled with -9999.d0 for every word in the record. Each record has the following data in the order listed:

(1) record count (double precision) - the record number in the block (1-125)

(2) station ID number (double precision) - the TRWID number of the radar station. Numbers under 100 are high rate(tenth second data) stations. Stations over 100 are low rate stations and are normally S-band stations. It is possible to get high rate and low rate data from the same station on this file. If this occurs the high rate data will be processed.

(3) time (double precision) - the time tag of the data on the record. The data is time taged in seconds from midnight the day of launch.

(4) range (double precision) - the range measurement for that time interval. Data is measured in feet.

(5) elevation or X angle (double precision) - this measurement is an angle measurement. Elevation is measured on all C-band stations; X angle of the keyhole measurement for all S-band stations. Measurements are in radians.

(6) azimuth or Y angle (double precision) - this measurement is an angle measurement. Azimuth is measured on all C-band stations; Y angle of the keyhole measurement for all S-band stations. Measurements are in radians.

(7) Doppler counts (double precision) - this measurement is the Doppler

counts for the S-band stations; it has no value for a C-band station. The measurement is dimensionless.

(8) station frequency (double precision) - this measurement contains the frequency of the S-band stations and is undefined for the C-band stations. The data is not used.

44.2.4 Messages

Error Messages

The following error message will be output to the screen if an I/O error occurs:

"TAPE ERROR"

This error is possible if the input tape unit is not correct or if something is incorrect on the tape reading.

Normal Messages

The following sample message will occur at the end of the tape processing:

```
" XXXXXX   RECORDS WRITTEN TO FILE  AAAAAAAAAA
  MINIMUM RECORD= YYYYY  WORDS
  MAXIMUM RECORD= ZZZZZ  WORDS"
```

Where the XXXXX is the number of records written to the file whose name is AAAAAAAA. The smallest record size was YYYYY words long. The longest record size was ZZZZZ words long. These outputs should compare favorably with the dump records that accompany the data tape.

45.0 SHELL SCRIPTS

The UNIX system provides the user with a mechanism called a "shell script" which allows a set of control command language to be executed in sequence. This allows the user to pre-program a set of programs with utility control instructions interspersed. The Ascent/Descent production process makes heavy use of this capability. The SHELL SCRIPS used in the production process are described in this section.

45.1 AQAFILTER/DQAFILTER

These shell script are not user interactive. AQAFILTER/DQAFILTER are two shell scripts. AQAFILTER is run during an ascent mission and DQAFILTER is run during a descent mission. The scripts are identical except that DQAFILTER plots the MSBLS range biases. AQAFILTER/DQAFILTER are executed after the program, LRBET5, to perform a quick check on the quality of the filter output. The shell script generates the plot labels and calls the program, QA, to plot various parameters versus time. The plots are then sent to the plotter attached to the terminal.

45.1.1 AQAFILTER/DQAFILTER Execution Procedure

These shell scripts are configured in the /users/Adheaven/Utilities subdirectory. The user must have executed LRBET5 establishing TAPE9 as an input file. The shell script must be executed in the file containing the input file, TAPE9. Normal setup of the production directory will copy the current version of the executable program, QA, into the production directory. An internal printer/plotter must be attached to the terminal to receive the plots. The shell script, AQAFILTER/DQAFILTER, is accessed by the PATH to the /users/Adheaven/Utilities/directory. The shell script is executed by entering

aqafilter xxxx or dqafilter xxxx

where the xxxx is the flight number. The shell script will execute without the flight number but the plot routine picks up the flight number and adds it to each plot. The shell script cannot be executed in the background mode since the plotter is necessary for the nine plots on ascent runs and ten plots on descent runs. The run time is approximately 20 minutes.

45.2 ARCHIVE

This shell script is not user interactive. It is designed to clean up the production directory after a mission such that the files left in the directory can be saved on one tape for archival purposes. The data files read from tapes are saved. The input and output files of INPUT are saved to allow exact reconstruction of the mission if desired. Some of the intermediate files are saved to speed reconstruction if a complete rerun is necessary. Print files and most intermediate files are moved to an ARCH directory where they can be removed at the users convenience. The files remaining in the production directory can be saved on one tape using FILER.

45.2.1 ARCHIVE Execution Procedure

The shell script is located in /users/Adheaven/Utilities subdirectory. Normal login to the production directory provides access to this shell through the PATH assigned in the ".profile". Execution should occur in the production directory desired to be archived. Execution is accomplished by entering

```
archive
```

Run time is less than two minutes. After completion of ARCHIVE, final archival storage is accomplished by executing FILER in the production directory.

45.3 AUTOSELECT

This shell script is not user interactive. It incorporates four configured programs to accomplish the automatic selection of the radars used for input to the filter; the reselection of those radars based on the results of the filter run; and incorporating the new radar selection in a new filter run. Final results of the shell script provide inputs to the MERGE program, in addition to the files used for QA analysis of the entire process. The shell script does the following functions:

(1) Separate the RDRDATA file into individual files.

(2) Scan those individual files for duplicate high/low rate files eliminating the duplicate low rate radar files

(3) Merge the radar data into 3 C-band, and an S-band file.

(4) Read each radar file setting up statistical files to use in selecting the 'best' radar for each 10 second interval.

(5) Build files for input to the filter composed of the 'best' radar for the filter to use based on the onboard estimates of position.

(6) Run a short filter process for QA purposes.

(7) Set up a long filter run and executes it.

(8) Reselect radars based on statistics from the just completed long filter process.

(9) Set up and execute a short filter process for QA purposes.

(10) Set up a long filter run and execute it based on the new radar selection.

(11) Execute SPLINE for an onboard trajectory comparison for QA.

45.3.1 AUTOSELECT Execution Procedure

This shell script is configured in the /users/Adheaven/Utilities subdirectory. The user must have executed UN2HP establishing RDRDATA as an input file. The user must have executed TELMTR establishing TAPE10 as an input file. The user must have executed UN2HP establishing OBDATA as an input file. On descent, the user must also have executed MSBLS successfully establishing TAPE16, TAPE17, and TAPE18 or modified the input data of the 'P' array to indicate that the MSBLS data will not be used. Finally, the execution of INPUT must have been successfully accomplished containing sufficient data to execute the process. Files generated by INPUT necessary for the execution of AUTOSELECT are : LRBET5.IN, RADSELECT.IN, and SPLINE.IN. This shell script must be executed in the file containing the input files. The PATH must be such that the Adheaven/Utilities directory will be accessed to find AUTOSELECT. Normal entry to a production directory (i.e., login to Adprodct) will establish to correct PATH for executing the shell script. Execution is accomplished by entering

```
autoselect
```

Run time is approximately 4-6 hours depending on how many other users there are.

45.3.2 AUTOSELECT Sample Input AUT066

The following is a compressed sample of the AUT066 formatted file:

```
obselect
 t= .4582000000E+05    imu  0    c1  0  0  0  0    c2  0  0    c3  0  0
 s1  0  0  0   tdrs  0  0   rmls  0  0   amls  0  0   wmls  0  0
 the kalman filter state vector and its sigmas are
```

```
 .5316701E+7 .2538699E+7 -.3197291E+7 -.3484647E+4 .6873763E+4 -.3394123E+3
 .5485E+03    .5718E+03    .1424E+03    .7706E+00    .1491E+00    .4179E+00
      imu misalinements                    c1 biases              c2 bias   c3 bias
.2743E-3 -.4079E-3 -.4383E-4   -.1303E+0 .2176E-7 .8673E-7  -.2158E-1  .0000E+0
.5821E-3  .5862E-3  .5794E-3    .3231E+2 .9590E-4 .1469E-3   .3231E+2  .3231E+2
        s1 biases             tdrs                        mls biases
-.4493E-1  -.1908381E+8   .000000000E+0      .0000E+0   .0000E+0   .0000E+0
 .2800E+2   .5098979E+1   .100000000E+33     .8000E+1   .3500E-3   .3500E-3
geod lat=-28.459deg long= 83.305deg alt=178.19n.mi. semimaj axis a=6708292.7m
sig a= .23974E+03 meters
 as=     .000     .000     .000           attl=  -7.036  -3.356   4.242
the cuvw matrix is
.3057090E+3 -.7941390E+0 .7143969E-2 .9167063E+0 -.9419194E+0 -.7539046E-1
.0000000E+0  .7398558E+3-.1007304E-1-.9626810E+0  .8294149E+0  .1327648E+0
.0000000E+0  .0000000E+0 .8517971E+2 .7052454E-2 -.1047746E-1 -.1595100E+0
.0000000E+0  .0000000E+0 .0000000E+0 .8410355E+0 -.8996078E+0 -.1148705E+0
.0000000E+0  .0000000E+0 .0000000E+0 .0000000E+0  .2605458E+0  .8488105E-1
.0000000E+0  .0000000E+0 .0000000E+0 .0000000E+0  .0000000E+0  .1247796E+0

        the total number of mass storage records is nms=2931.
    s1 doppler residual edit at t= .4291300000E+05 seconds for station id=20
    s1 doppler residual edit at t= .4291500000E+05 seconds for station id=20
    s1 doppler residual edit at t= .4291600000E+05 seconds for station id=20
          --etc., all the edits by the lrbet5 process---
    s1 doppler residual edit at t= .4334900000E+05 seconds for station id= 3
    s1 doppler residual edit at t= .4335000000E+05 seconds for station id= 3
    c1 range residual edit at t= .4353700000E+05 seconds for station id= 2
    c1 range residual edit at t= .4354100000E+05 seconds for station id= 2
    c1 range residual edit at t= .4354300000E+05 seconds for station id= 2
lrselect

t=.4582000E+5  imu  0  c1  0  0  0  0   c2  0  0   c3  0  0
s1  0  0  0   tdrs  0  0   rmls  0  0   amls  0  0   wmls  0  0
the kalman filter state vector and its sigmas are
.5316825E+7 .2538585E+7 -.3197343E+7 -.3484432E+4 .6873798E+4 -.3394469E+3
.5450E+3    .5677E+3    .1409E+3    .7646E+0    .1471E+0    .4157E+0
```

```
    imu misalinements                      c1 biases               c2 bias      c3 bias
.2447E-3 -.3853E-3 -.1283E-5  -.1307E+0 .1566E-7 .6856E-7  .3883E-1    .0000E+0
.5820E-3  .5857E-3  .5792E-3   .3231E+2 .9652E-4 .1474E-3  .3231E+2    .3231E+2
      s1 biases             tdrs                       mls biases
-.5471E-1 -.1908381E+8   .0000000E+00   .0000E+0 .0000E+0  .0000E+0
 .2800E+2  .4836172E+1   .1000000E+33   .8000E+1 .3500E-3  .3500E-3
geod lat=-28.460deg long= 83.304deg alt=178.23n.mi. semimaj axis a=6708341.6m
sig a= .23857E+3m
as=   .000   .000   .000            attl=  -7.036  -3.356   4.242
the cuvw matrix is
.3033442E+3 -.7950548E+0 .1373509E-1 .9175365E+0 -.9411076E+0 -.8520926E-1
.0000000E+0  .7348932E+3-.2073181E-1-.9624870E+0  .8308018E+0  .1497223E+0
.0000000E+0  .0000000E+0 .8447831E+2 .1712497E-1 -.1674600E-1 -.1360401E+0
.0000000E+0  .0000000E+0 .0000000E+0 .8350677E+0 -.9001896E+0 -.1304887E+0
.0000000E+0  .0000000E+0 .0000000E+0 .0000000E+0  .2588088E+0  .9464654E-1
.0000000E+0  .0000000E+0 .0000000E+0 .0000000E+0  .0000000E+0  .1213873E+0

     the total number of mass storage records is nms=2931.
s1 doppler residual edit at t= .4291300000E+05 seconds for station id=20
s1 doppler residual edit at t= .4291500000E+05 seconds for station id=20
s1 doppler residual edit at t= .4291600000E+05 seconds for station id=20
       -- etc., all edits from the LRBET5 process--
s1 doppler residual edit at t= .4328000000E+05 seconds for station id= 3
s1 doppler residual edit at t= .4328100000E+05 seconds for station id= 3
c1 range residual edit at t= .4353700000E+05 seconds for station id= 2
c1 range residual edit at t= .4354300000E+05 seconds for station id= 2
```

45.4 DUMPLOG

This shell script is not user interactive. It is designed to provide an accounting method for determining the time usage for each program and for each mission. The shellscript scans the log of all of the programs that were initiated with TIMER either directly or indirectly. Each time a program is initiated using TIMER a report of the time usage is saved in a file called ".LOG" in the ADPRODCT directory. DUMPLOG dumps this file to the printer and on the way scans the data, sorts the time by program and by mission, and sums the time by each mission. The summary reports are printed with the log.

45.4.1 DUMPLOG Execution Procedure

The shell script is located in /users/Adheaven/Utilities subdirectory. Normal login to the production directory provides access to this shell through the PATH assigned in the ".profile". Execution must occur in any production directory to provide the accounting of time usage since the last DUMPLOG execution. Execution is accomplished by entering

```
dumplog
```

Run time is about three minutes.

45.4.2 DUMPLOG Sample Output

The following is a compressed sample of the DUMPLOG output:

```
.............                  ]
Thu Aug 21 06:45:31 CDT 1986   ]        -- (Example of login) --
john                           ]
.............D61CTest          ]
::::::::::::::                         ]
gtrack.x.time                          ]
::::::::::::::                         ]
______________________________         ]
Thu Aug 21 20:00:11 CDT 1986           ]
*** gtrack.x ***                       ]     -- (Example of execution) --
                                       ]
real        10.4                       ]
user         7.0                       ]
sys          2.2                       ]
/datal/Adprodct/D61CTest               ]
```

```
Thu Aug 21 20:00:23 CDT 1986          ]
______________________________        ]


::::::::::::::
autoselect.time
::::::::::::::
______________________________
Thu Aug 21 20:05:18 CDT 1986
*** autoselect ***

real  5:54:20.7
user  4:52:51.7
sys     23:32.0
/datal/Adprodct/D61CTest
Fri Aug 22 01:59:40 CDT 1986
______________________________

::::::::::::::
wbc.time
::::::::::::::
______________________________
Thu Aug 21 20:00:09 CDT 1986
*** wbc ***

real  7:46:52.3
user  6:38:46.4
sys     28:39.0
/datal/Adprodct/D61CTest
Fri Aug 22 03:47:02 CDT 1986
______________________________

  SUMMARY DATA FOR DUMP                                      ]
                                                             ]
D61CTest    autoselect    3    12189.1    609.455            ]
D61CTest    clear5.x     18    3.58333    1.075              ]
```

```
D61CTest    gtrack.x     3    10.2667    0.513333          ]
D61CTest    i2iipc.x     3    26.7    1.335                ]
D61CTest    lrbet5.x     15    2681.47    670.368          ]
D61CTest    merge.x    3    227.1    11.355                ]
D61CTest    metgraph.x    3    16.0667    0.803333         ]  __ (Example of
D61CTest    opip.x    3    2014.73    100.737              ]      accounting)
D61CTest    radselect.x    6    952.933    95.2933         ]
D61CTest    rdrmrg.x     3    217.333    10.8667           ]
D61CTest    runbea.x     3    112.967    5.64833           ]
D61CTest    spline.x     3    367.167    18.3583           ]
D61CTest    telmtr.x     3    290.4    14.52               ]
D61CTest    wbc    3    14921.6    746.08                  ]
---------------------------------------------------        ]
----- Flight totals  D61CTest      137184      2286.41     ]
                                                           ]
     END OF DUMP                                           ]
Fri Aug 22 09:26:24 CDT 1986                               ]

  SUMMARY DATA FOR DUMP

Q61CTest    rdrmrg.x    1    217    3.61667
---------------------------------------------------
----- Flight totals  Q61CTest      217      3.61667

     END OF DUMP
Fri Aug 22 09:26:24 CDT 1986
```

45.5 QAIMU

This shell script is not normally user interactive. The purpose of QAIMU is to iteratively call the program QA in order to plot various parameters in the files QADATA1, and IMUxDT. The purpose of this shell script is to display the quality of the accelerometer data.

45.5.1 QAIMU Execution Procedure

Before running QAIMU, TELMTR must be have been executed successfully generating QADATA1 and IMUxDT, where the "x" of IMUxDT are the numbers 1,2 or 3. Execution of QAIMU must be accomplished in the directory where the input files are located. To execute QAIMU, the user types in and executes

qaimu XXXX

where XXXX is the flight number. Failure to enter the flight number will result in a statement from the shell script and the shell script will terminate. The shell script cannot be executed in background mode since the plotter is necessary.

45.6 QAMETGRAPH

The shell script is not user interactive. QAMETGRAPH executes the program METGRAPH and the program QA to plot the output of METGRAPH. METGRAPH reads the MET (meteorological data) file, determines the corrections to altitude, corrects them, and rewrites the file as CMETDATA. QAMETGRAPH also generates the labels for the plots and calls QA to plot the five meteorlogical parameter plots for each totum given in the MET file.

45.6.1 QAMETGRAPH Execution Procedure

This shell script is configured in the /users/Adheaven/Utilities subdirectory. The user must have executed HPMET establishing MET as an input file. The shell script must be executed in the directory containing the input file. Normal setup of the production directory will copy the current version of the executable programs, QA and METGRAPH, into the production directory. An internal printer/plotter must be attached to the terminal to receive the plots. The shell script, QAMETGRAPH, is accessed by the PATH to the /users/Adheaven/Utilities/ directory. The shell script is executed by entering qametgraph

The shell script cannot be executed in background mode since the plotter is necessary for the five plots per totum. The run time is approximately four minutes per totum.

45.7 QAMSLRRESID

This shell script is not user interactive. QAMSLRRESID executes the program MSLRRESID and the program QA to plot the output of MSLRRESID. MSLRRESID computes msbls range, azimuth, and elevation residuals with respect to the output of the LRBET5 filter. QAMSLRRESID generates the labels for the plots and calls QA to plot the three residual plots.

45.7.1 QAMSLRRESID Execution Procedure

This shell script is configured in the /users/Adheaven/Utilities subdirectory. The user must have executed LRBET5 establishing TAPE9 as an input file. The user must have executed INPUT establishing MSLRRESID.IN as an input file. The user must have executed MSBLS establishing TAPE16, TAPE17, and TAPE18 as input files. The shell script must be executed in the directory containing the input files. Normal setup of the production directory will copy the current version of the executable programs, QA and MSLRRESID, into the production directory. An internal printer/plotter must be attached to the terminal to receive the plots. The shell script, QAMSLRRESID, is accessed by the PATH to the /users/Adheaven/Utilities/ directory. The shell script is executed by entering

qamslrresid

This shell script cannot be executed in background mode since the plotter is necessary for the three plots. Run time is approximately three minutes.

45.8 QAMSOBRESID

This shell script is not user interactive. QAMSOBRESID executes the program MSOBRESID and the program QA to plot the output of MSOBRESID. MSOBRESID computes msbls range, azimuth, and elevation residuals with respect to the onboard estimated state vector. QAMSOBRESID generates the labels for the plots and calls QA to plot the three residual plots.

45.8.1 QAMSOBRESID Execution Procedure

This shell script is configured in the /users/Adheaven/Utilities subdirectory. The user must have executed UN2HP establishing OBDATA as an input file. The user must have executed INPUT establishing MSOBRESID.IN as an input file. The user must have executed MSBLS establishing TAPE16, TAPE17, and TAPE18 as input files. The shell script must be executed in the directory containing the input files. Normal setup of the production directory will copy the current version of the executable programs, QA and MSOBRESID, into the production directory. An internal printer/plotter must be attached to the terminal to receive the plots. The shell script, QAMSOBRESID, is accessed by the PATH to the /users/Adheaven/Utilities/ directory. The shell script is executed by entering

```
qamsobresid
```

This shell script cannot be executed in background mode since the plotter is necessary for the three plots. Run time is approximately three minutes.

45.9 QAOPIP

This shell script is not user interactive. QAOPIP is executed after the program, OPIP, to perform a quick check on the quality of the output product. The shell script generates the plot labels and calls the program, QA, to plot various parameters versus time. The plots are then sent to the plotter attached to the terminal.

45.9.1 QAOPIP Execution Procedure

This shell script is configured in /users/Adheaven/Utilities subdirectory. The user must have executed OPIP establishing BETDATA as an input file. The shell script must be executed in the file containing the input file, BETDATA. Normal setup of the production directory will copy the current version of the executable program, QA, into the production directory. An internal printer/plotter must be attached to the terminal to receive the plots. The shell script, QAOPIP, is accessed by the PATH to the /users/ Adheaven/Utilities/directory. The shell script is executed by entering

qaopip xxxx

where the xxxx is the flight number. The shell script will execute without the flight number but the plot routine picks up the flight number and adds it to each plot. The shell script cannot be executed in background mode since the plotter is necessary for the sixteen plots. Run time is approximately 20-25 minutes.

45.10 QAPLOTDIFF

This shell script is not user interactive. It incorporates the QA plot program to plot the radar to LRBET5 differences recorded in the PLTDIFx files after the execution of RADSELECT. This shell script does the following:

(1) Set up for an undetermined number of plots.

(2) Generate the files of escape codes for skipping lines on the internal plotter, the copy command for the plot, and the resetting commands.

(3) Set up the labels for the plots.

(4) Generate the input file expected by QA.

(5) Plot the variable on the screen.

(6) Command the screen to internal plotter transfer.

(7) Reset the screen for the next plot.

(8) Repeat steps (3) to (7) until all variables have been plotted.

45.10.1 QAPLOTDIFF Execution Procedure

This shell script is configured in the /users/Adheaven/Utilities subdirectory. The user must have executed RADSELECT either directly or indirectly through AUTOSELECT. RADSELECT establishes the PLTDIFx files as input files for QAPLOTDIFF. The shell script must be executed in the directory containing the input files, PLTDIFx. An internal printer/plotter must be attached to the terminal to receive the plots. Normal setup of the production directory will copy the current version of the executable program, QA, into the production directory. The shell script, QAPLOTDIFF, is accessed by the PATH to the /users/Adheaven/Utilities/ directory. the shell script is executed by entering

```
qaplotdiff
```

The shell script cannot be executed in background mode since the plotter is necessary for the plots. The run time is about one minute per plot. The number of plots is dependent on the number of useful files, PLTDIFx. There are five plots per C-band file and six plots per S-band file. Normally, there are only three files with usable data. If full playback radar data is provided, there may six files with useful data.

45.11 QAQUAT

This shell script is not user interactive. QAQUAT executes the program, QUATQA, to build the file, ROTATIONS, and then executes the program, QA, which plots the file, ROTATIONS.

45.11.1 QAQUAT Execution Procedure

This shell script is configured in the /users/Adheaven/Utilities subdirectory. The user must have executed RUNBEA establishing BEADATA as an input file. The shell script must be executed in the file containing the input file, BEADATA. Normal setup of the production directory will copy the current version of the executable programs, QA and QUATQA, into the production directory. An internal printer/plotter must be attached to the terminal to receive the plots. The shell script, QAQUAT, is accessed by the PATH to the /users/Adheaven/Utilities directory. The shell script is executed by entering

qaquat

The shell script cannot be executed in the background mode since the plotter is necessary for the three plots. The run time is approximately three minutes.

45.12 QASPLINE

This shell script is not user interactive. It incorporates the QA plot program to plot the UVW position and velocity data recorded in the SPLINEPLT file after the execution of SPLINE. This shell script does the following:

(1) Set up the labels for the plots.

(2) Generate the files of escape codes for skipping lines on the internal plotter, the copy command for the plot, and the resetting commands.

(3) Generate the input file expected by QA to plot a file variable.

(4) Plot the variable on the screen.

(5) Command the screen to internal plotter transfer.

(6) Reset the screen for the next plot.

(7) Repeat steps (3) to (6) until all variables have been plotted.

45.12.1 QASPLINE Execution Procedures

This shell script is configured in the /users/Adheaven/Utilities subdirectory. The user must have executed SPLINE establishing SPLINEPLT as an input file. The shell script must be executed in the file containing the input file, SPLINEPLT. Normal setup of the production directory will copy the current version of the executable program, QA, into the production directory. An internal printer/plotter must be attached to the terminal to receive the plots. The shell script, QASPLINE, is accessed by the PATH to the /users/Adheaven/Utilities directory. The shell script is executed by entering

"qaspline"

The shell script cannot be executed in background mode since the plotter is necessary for the six plots. The runtime is about 6 minutes or about a minute per plot.

45.13 SETUPASCENT/SETUPDESCENT

This shell script is not user interactive. It is designed to set up the production directory before a mission such that the files put in the directory are the current executable programs to run a mission. The shell script also loads the ascent or descent default files into the production directory.

45.13.1 SETUPASCENT/SETUPDESCENT Execution Procedure

This shell script is located in /users/Adheaven/Utilities subdirectory.

Normal production login with correct PATH instructions is all that is required to run this shell. The first procedure is to set up a production directory. From the /datal/Adprodct directory, execute

mkdir

using the correct production directory name. After the correct production directory is generated, change to that directory by using the "cd" command. Execution of the SETUPASCENT/SETUPDESCENT shell script is accomplished by entering and executing

setupascent

for an ascent run or

setupdescent

for a descent run. Run time is less than two minutes.

45.14 TIMER

This shell script is not user interactive. TIMER is an accounting program for the Ascent/Descent process. TIMER initiates a program and records the results of the resources used during execution. The output is to the file "/datal/Adprodct/.log".

45.14.1 TIMER Execution Procedure

TIMER was developed to effectively keep track of the resources used in the Ascent/Descent process. This shell script logs the execution times of the programs executed during the develoment process. TIMER must execute each of the programs in the Ascent/Descent process to effectively do this. To use TIMER to execute a program, such as LRRESID, while keeping track of the time of the execution of LRRESID, the user types in timer lrresid

TIMER records the time of execution in "datal/Adprodct/.log".

45.14.2 TIMER Sample Output

The following is a sample of the information written to the file "/datal/Adprodct/.log" as a result of the command "timer lrresid".

```
::::::::::::::
lrresid.x.time
::::::::::::::
```

```
Wed Aug 27 13:49:33 CDT 1986
*** lrresid.x ***

real        2.3
user        0.0
sys         1.0
/datal/Adprodct/D61CTest
Wed Aug 27 13:49:36 CDT 1986
```

46.0 DIRECTORIES

The Ascent/Descent Production process uses a variety of programs, routines, and input files. These are stored in four directories, the contents of which are specified in this section.

A directory listing which shows the file content of a directory is shown for each directory. Each listing contains seven columns of information. The first column shows the read/write/execute permission (see unix system description). The second column contains a number specifying the number of links to the file (see unix system description). The third and fourth column contain the user and group IDs. The fifth column is the number of bytes in the file. The date and time of last modification to the file is next. The last column is the name of the file.

46.1 DEFAULT

DEFAULT is the directory containing the files used in the program INPUT. The files in DEFAULT contain the initial values used in the Ascent/Descent system. The files are copied to the production directory by SETUP. The data in these files are usually changed during the course of a mission, however the files in DEFAULT are not changed.

46.1.1 DEFAULT LISTING

```
total 136
-rw-r--r--   1 adheaven ADPRODCT    3015 Jul  28 11:39 acgtable
-rw-r--r--   1 adheaven ADPRODCT    1114 Jul  28 11:39 adel_intrvls
-rw-r--r--   1 adheaven ADPRODCT     602 Jul  28 11:39 adewpoints
-rw-r--r--   1 adheaven ADPRODCT     779 Jul  28 11:39 aimumats
-rw-r--r--   1 adheaven ADPRODCT    1349 Jul  28 11:39 aimuselect
-rw-r--r--   1 adheaven ADPRODCT    1583 Jul  28 11:39 aradselect
-rw-r--r--   1 adheaven ADPRODCT    1400 Jul  28 11:39 arcv
-rw-r--r--   1 adheaven ADPRODCT     698 Jul  28 11:39 arefsmats
```

```
-rw-r--r--   1 adheaven ADPRODCT     225 Jul 28 11:39 asband
-rw-r--r--   1 adheaven ADPRODCT    7093 Jul 28 11:39 aset
-rw-r--r--   1 adheaven ADPRODCT     164 Jul 28 11:39 astart-stop
-rw-r--r--   1 adheaven ADPRODCT     125 Jul 28 11:39 aupdate_vec
-rw-r--r--   1 adheaven ADPRODCT    3014 Jul 28 11:39 dcgtable
-rw-r--r--   1 adheaven ADPRODCT    1115 Jul 28 11:39 ddel_intrvls
-rw-r--r--   1 adheaven ADPRODCT     125 Jul 28 11:39 ddeorbit_vec
-rw-r--r--   1 adheaven ADPRODCT     602 Jul 28 11:39 ddewpoints
-rw-r--r--   1 adheaven ADPRODCT     779 Jul 28 11:39 dimumats
-rw-r--r--   1 adheaven ADPRODCT    1349 Jul 28 11:39 dimuselect
-rw-r--r--   1 adheaven ADPRODCT    1623 Jul 28 11:39 dradselect
-rw-r--r--   1 adheaven ADPRODCT    1397 Jul 28 11:40 drcv
-rw-r--r--   1 adheaven ADPRODCT     698 Jul 28 11:40 drefsmats
-rw-r--r--   1 adheaven ADPRODCT      72 Jul 28 11:40 drunwaydata
-rw-r--r--   1 adheaven ADPRODCT     225 Jul 28 11:40 dsband
-rw-r--r--   1 adheaven ADPRODCT    7093 Jul 28 11:40 dset
-rw-r--r--   1 adheaven ADPRODCT     164 Jul 28 11:40 dstart-stop
-rwxr--r--   1 adheaven ADPRODCT    3024 Jul 28 11:49 radar
-rwxr--r--   1 adheaven ADPRODCT   15426 Jul 28 11:49 runway
```

46.2 EXECUTE

EXECUTE is the directory containing all the programs in the Ascent/Descent process in the form of executable code. The programs are copied into the production directory by SETUP. The latest version of all the programs are stored in EXECUTE with the program name followed by ".x".

46.2.1 EXECUTE LISTING

```
total 9842
-rwxr-xr--   1 adheaven ADPRODCT   67122 Feb  5  1985 attest.x
-rwxr-xr-x   1 adheaven ADPRODCT  106454 Aug  6 14:09 clear5.x
-rwxr-xr-x   1 adheaven ADPRODCT  134058 May 22 09:09 editimubea.x
-rwxr-xr-x   1 adheaven ADPRODCT   88631 May 22 09:15 editmsbls.x
```

```
-rwxr-xr-x   1 adheaven ADPRODCT   88229 Aug  7 09:45 fichout.x
-rwxr-xr-x   1 adheaven ADPRODCT  105565 Aug  4 15:52 gtrack.x
-rwxr-xr-x   1 adheaven ADPRODCT   91258 Aug  7 10:38 hp2cy.x
-rwxr-xr-x   1 adheaven ADPRODCT   89165 Aug  7 11:02 hp2unv.x
-rwxr-xr-x   1 adheaven ADPRODCT   82408 May 22 10:01 hpmet.x
-rwxr-xr-x   1 adheaven ADPRODCT  133897 Aug  8 09:33 hpnav2cy.x
-rwxr-xr-x   1 adheaven ADPRODCT  188608 Aug  8 09:44 hpnav2unv.x
-rwxr-xr-x   1 adheaven ADPRODCT  113901 Aug  5 07:53 i2iipc.x
-rwxr-xr-x   1 adheaven ADPRODCT   85271 May 22 10:36 ild.x
-rwxr-xr-x   1 adheaven ADPRODCT  396041 Sep  4 10:58 input.x
-rwxr-xr-x   1 adheaven ADPRODCT  122416 Aug  5 08:41 landqa.x
-rwxr-xr-x   1 adheaven ADPRODCT  297279 Aug  5 10:22 lrbet5.x
-rwxr-xr-x   1 adheaven ADPRODCT  148492 Aug  5 10:39 lrresid.x
-rwxr-xr-x   1 adheaven ADPRODCT  124806 Aug  5 11:24 merge.x
-rwxr-xr-x   1 adheaven ADPRODCT  148362 Jul 28 11:30 metgraph.x
-rwxr-xr-x   1 adheaven ADPRODCT   79878 Aug  5 13:09 msbls.x
-rwxr-xr-x   1 adheaven ADPRODCT   84062 Aug  5 13:25 mslrresid.x
-rwxr-xr-x   1 adheaven ADPRODCT   84406 Aug  5 13:38 msobresid.x
-rwxr-xr-x   1 adheaven ADPRODCT  228618 Aug  5 14:30 opip.x
-rwxr-xr-x   1 adheaven ADPRODCT  166738 May 22 13:27 qa.x
-rwxr-xr-x   1 adheaven ADPRODCT  119646 Aug 18 07:18 qalrresid.x
-rwxr-xr-x   1 adheaven ADPRODCT  119452 Aug 18 07:30 qaresid.x
-rwxr-xr--   1 adheaven ADPRODCT  117622 Feb  5  1985 qc.x
-rwxr-xr-x   1 adheaven ADPRODCT   77208 May 22 13:39 quatqa.x
-rwxr-xr-x   1 adheaven ADPRODCT  105816 Aug  5 15:12 radar5.x
-rwxr-xr-x   1 adheaven ADPRODCT  206907 Aug  6 13:52 radselect.x
-rwxr-xr-x   1 adheaven ADPRODCT  149656 Aug  5 15:42 raecomp.x
-rwxr-xr-x   1 adheaven ADPRODCT  129437 Aug 13 09:20 rdrmrg.x
-rwxr-xr-x   1 adheaven ADPRODCT  119405 Aug  6 07:55 rdrpos.x
-rwxr-xr-x   1 adheaven ADPRODCT  121416 Sep  4 10:39 runbea.x
-rwxr-xr-x   1 adheaven ADPRODCT  120314 Aug  6 08:34 spline.x
-rwxr-xr-x   1 adheaven ADPRODCT  149496 Aug  6 09:08 statcom.x
-rwxr-xr-x   1 adheaven ADPRODCT  139468 Aug 18 09:42 telmtr.x
-rwxr-xr-x   1 adheaven ADPRODCT   86601 Aug  7 10:08 un2hp.x
```

46.3 HELL

HELL is a directory containing the source version of the programs prior to the most recent version. The source code allows comparison and a fall-back option if the most recent version of the program contains a software bug not detected in the testing process.

46.2.1 HELL LISTING

```
total 2954
-rwxrwxr--   1 adheaven ADPRODCT     810 Jun 12  1985 aqalrmerge
-rwxr-xr-x   1 adheaven ADPRODCT     822 May 13 15:45 autoselect
-rwxr--r--   1 adheaven ADPRODCT   62484 Jun  2 11:25 bigmdv.b
-rwxr--r--   1 adheaven ADPRODCT   14557 Dec 12  1985 bpnl.b
-rwxrwxr--   1 adheaven ADPRODCT     378 Feb  5  1985 bufin.c
-rwxr--r--   1 adheaven ADPRODCT   15105 May 22 09:47 cdcout.c
-rwxrwxr--   1 adheaven ADPRODCT     828 Jun 12  1985 dqalrmerge
-rwxr--r--   1 adheaven ADPRODCT    2496 May 22 15:00 ebcdic.c
-rwxr--r--   1 adheaven ADPRODCT   17169 Aug 23  1985 editrss.b
-rwxr--r--   1 adheaven ADPRODCT   10059 May 22 09:28 getrss.b
-rwxr--r--   1 adheaven ADPRODCT   11305 Feb  5  1985 gtrack.b
-rwxr-xr--   1 adheaven ADPRODCT    3349 Sep 23  1985 hp2cy.b
-rwxr--r--   1 adheaven ADPRODCT    3185 Aug 22  1985 hp2unv.b
-rwxrwxr--   1 adheaven ADPRODCT     908 Feb  5  1985 hpmet.f
-rwxr--r--   1 adheaven ADPRODCT   27393 Feb  5  1985 i2iipc.b
-rwxrwxr--   1 adheaven ADPRODCT    2178 Aug 12  1985 idm.c
-rwxrwxr--   1 adheaven ADPRODCT    3740 Aug 12  1985 ild.b
-rwxr--r--   1 adheaven ADPRODCT   74003 Aug  8 15:11 input.b
-rwxr--r--   1 adheaven ADPRODCT   73889 Aug  6 11:25 inputl.b
-rwxr--r--   1 adheaven ADPRODCT   16938 Feb  5  1985 int.b
-rwxr--r--   1 adheaven ADPRODCT   17637 May  2 10:11 landqa.b
-rwxr--r--   1 adheaven ADPRODCT   35270 May  2 13:47 lrbet5.f
-rwxrwxr--   1 adheaven ADPRODCT    5017 Feb 19  1986 lrmerge.b
-rwxrwxr--   1 adheaven ADPRODCT    4957 Feb  5  1985 lrmerge.x
-rwxr--r--   1 adheaven ADPRODCT   26863 Dec 12  1985 lrresid.f
```

```
-rwxr--r--   1 adheaven ADPRODCT   59686 Jan 24  1986 manage.b
-rwxr--r--   1 adheaven ADPRODCT   19840 Jun  2 07:49 merge.b
-rwxrwxr--   1 adheaven ADPRODCT   67690 Jun 11  1985 metgraph.b
-rwxr--r--   1 adheaven ADPRODCT   12241 Feb  5  1985 metqa.b
-rwxrwxr--   1 adheaven ADPRODCT   12680 May  2 10:51 miscs.b
-rwxr--r--   1 adheaven ADPRODCT    5913 Feb  5  1985 msbls.b
-rwxr--r--   1 adheaven ADPRODCT   12065 Apr 10  1985 mslrresid.b
-rwxr--r--   1 adheaven ADPRODCT   12477 Jun 17  1985 msobresid.b
-rwxr--r--   1 adheaven ADPRODCT   62663 Jun  2 10:09 opip.b
-rwxr--r--   1 adheaven ADPRODCT    2623 Feb  5  1985 postpc.b
-rwxrwxr--   1 adheaven ADPRODCT    6651 Feb  5  1985 preop.b
-rwxrwxr--   1 adheaven ADPRODCT   68683 Oct  9  1985 qa.f
-rwxr--r--   1 adheaven ADPRODCT   20957 Dec 12  1985 qalrresid.b
-rwxr--r--   1 adheaven ADPRODCT   20856 Dec 12  1985 qaresid.b
-rwxrwxr--   1 adheaven ADPRODCT   19945 Feb  5  1985 qc.f
-rwxrwxr--   1 adheaven ADPRODCT    2149 Apr 10  1985 quatqa.b
-rwxrwxr--   1 adheaven ADPRODCT   31823 Feb  5  1985 quats.b
-rwxr--r--   1 adheaven ADPRODCT   37712 Feb  5  1985 radar5.b
-rwxr--r--   1 adheaven ADPRODCT   80631 Jan 20  1986 radselect.b
-rwxr--r--   1 adheaven ADPRODCT   27137 Dec 12  1985 raecomp.f
-rwxr--r--   1 adheaven ADPRODCT    4864 Apr 10  1985 raepos.b
-rw-r--r--   1 adheaven ADPRODCT   14645 Aug 12 08:28 rdrmrg.b
-rwxr--r--   1 adheaven ADPRODCT   32972 Dec 12  1985 rdrpos.b
-rwxr--r--   1 adheaven ADPRODCT   12510 Feb  5  1985 rdrsep.b
-rwxr--r--   1 adheaven ADPRODCT    4369 Feb  5  1985 rduniv.c
-rwxrwxr--   1 adheaven ADPRODCT    2472 Jan 20  1986 readimu.b
-rwxr--r--   1 adheaven ADPRODCT   44059 Aug  6 08:13 runbea.b
-rwxr--r--   1 adheaven ADPRODCT   23858 May  2 09:33 spline.b
-rwxr--r--   1 adheaven ADPRODCT   10978 Feb  5  1985 split.b
-rwxr--r--   1 adheaven ADPRODCT   15489 Feb  5  1985 statcom.b
-rwxr--r--   1 adheaven ADPRODCT   45276 Jun  2 10:23 subop2.b
-rwxr--r--   1 adheaven ADPRODCT  100102 Aug  6 11:25 subopsinput.b
-rwxr--r--   1 adheaven ADPRODCT   62246 Jan 24  1986 subopsmanag.b
-rwxr--r--   1 adheaven ADPRODCT   45334 Apr 17  1986 telmtr.b
-rwxr--r--   1 adheaven ADPRODCT   33022 Feb  5  1985 tminpt.b
-rwxr--r--   1 adheaven ADPRODCT    7376 Aug 22  1985 unvout.c
-rwxr--r--   1 adheaven ADPRODCT    1606 Feb  5  1985 writef.f
```

46.4 LRBET5REL

Each of the LRBET5 subroutines is contained in its own file. LRBET5REL is a directory containing a copy of each of these subroutines in object code. Object code is the intermediate step between source code and executable code (i.e. it is the output of the compiler).

46.2.1 LRBET5REL LISTING

```
total 610
-r--r--r--   1 adheaven ADPRODCT    9216 Aug  5 09:51 accel2.o
-r--r--r--   1 adheaven ADPRODCT    1024 Aug  5 09:51 alt.o
-r--r--r--   1 adheaven ADPRODCT    1792 Aug  5 09:51 amat.o
-r--r--r--   1 adheaven ADPRODCT    3840 Aug  5 09:51 azmuth.o
-r--r--r--   1 adheaven ADPRODCT   20224 Aug  5 09:52 blkdata.o
-r--r--r--   1 adheaven ADPRODCT     768 Aug  5 09:52 copyxc.o
-r--r--r--   1 adheaven ADPRODCT    9216 Aug  5 09:52 covprp.o
-r--r--r--   1 adheaven ADPRODCT    2304 Aug  5 09:52 drag.o
-r--r--r--   1 adheaven ADPRODCT    1280 Aug  5 09:52 ef.o
-r--r--r--   1 adheaven ADPRODCT    4352 Aug  5 09:52 elev.o
-r--r--r--   1 adheaven ADPRODCT   13056 Aug  5 09:53 grav.o
-r--r--r--   1 adheaven ADPRODCT    2304 Aug  5 09:53 initrs.o
-r--r--r--   1 adheaven ADPRODCT    1792 Aug  5 09:53 initsl.o
-r--r--r--   1 adheaven ADPRODCT    4352 Aug  5 09:53 input.o
-r--r--r--   1 adheaven ADPRODCT    4608 Aug  5 09:53 intgtl.o
-r--r--r--   1 adheaven ADPRODCT    3328 Aug  5 09:53 intgtla.o
-r--r--r--   1 adheaven ADPRODCT    1280 Aug  5 09:53 intgt2.o
-r--r--r--   1 adheaven ADPRODCT    6400 Aug  5 09:53 intgt3.o
-r--r--r--   1 adheaven ADPRODCT    4352 Aug  5 09:54 invrs.o
-r-xr--r--   1 adheaven ADPRODCT     304 May  2 14:43 link.lrbet5
-r--r--r--   1 adheaven ADPRODCT    4608 Aug  5 09:54 locate.o
-r--r--r--   1 adheaven ADPRODCT  117248 Aug  5 09:57 lrbet5.o
-r--r--r--   1 adheaven ADPRODCT    4608 Aug  5 09:57 mlswdg.o
```

```
-r--r--r--   1 adheaven ADPRODCT   12032 Aug  5 09:57 outptk.o
-r--r--r--   1 adheaven ADPRODCT   14848 Aug  5 09:57 outpts.o
-r--r--r--   1 adheaven ADPRODCT    5120 Aug  5 09:58 phi.o
-r--r--r--   1 adheaven ADPRODCT    3840 Aug  5 09:58 range.o
-r--r--r--   1 adheaven ADPRODCT    1024 Aug  5 09:58 rblank.o
-r--r--r--   1 adheaven ADPRODCT    1024 Aug  5 09:58 rd.o
-r--r--r--   1 adheaven ADPRODCT    1792 Aug  5 09:58 refrc1.o
-r--r--r--   1 adheaven ADPRODCT    2304 Aug  5 09:59 refrc2.o
-r--r--r--   1 adheaven ADPRODCT    1280 Aug  5 09:59 refrc3.o
-r--r--r--   1 adheaven ADPRODCT    5376 Aug  5 09:59 root.o
-r--r--r--   1 adheaven ADPRODCT    2048 Aug  5 09:59 t4t4d.o
-r--r--r--   1 adheaven ADPRODCT    2304 Aug  5 09:59 t5mat.o
-r--r--r--   1 adheaven ADPRODCT    2304 Aug  5 09:59 test.o
-r--r--r--   1 adheaven ADPRODCT   10240 Aug  5 09:59 transt.o
-r--r--r--   1 adheaven ADPRODCT    1792 Aug  5 10:00 update.o
-r--r--r--   1 adheaven ADPRODCT    2560 Aug  5 10:00 updtsv.o
-r--r--r--   1 adheaven ADPRODCT    2816 Aug  5 10:00 uvw.o
```

47.0 SPECIAL SUBROUTINES

47.1 CDCOUT

CDCOUT is a "C" subroutine used in the HP2CY and HPNAV2CY programs. It coverts HP format to CDC Cyber format and writes the CDC compatible tape. It is linked with the HP2CY and HPNAV2CY programs as a separate subroutine and called by the main programs. It has its own directory.

The subroutine is never used independently and therefor never executed by it's self. The subroutine is always linked to the main program HP2CY or HPNAV2CY.

A small shell script kept in the directory with the subroutine is executed whenever a change is made in the subroutine. The shell script compiles the "C" routine and moves copies of the object code to the HP2CY and HPNAV2CY directories for linking with the main routines.

47.2 GETREC

GETREC is a "C" subroutine used in HPNAV2CY and HPNAV2UNV programs. It is designed to read the HP blocked NAVBLK data output file such that the file can be transformed into a foreign output format for the Univac and Cyber computers. It is linked with the HPNAV2UNV and HPNAV2CY programs as a separate subroutine and called by the main programs. It is not used independently. It has it's own directory since a change in the routine affects both of the main programs and the separate directory forces that recognition.

A small shell script kept in the directory with the subroutine is executed whenever a change is made in the subroutine. The shell script compiles the "C" routine and moves copies of the object code to the HPNAV2UNV and HPNAV2CY directories for linking with the main routines.

47.3 MACROS

This sub-directory in the configuration control directory (Adheaven) is used to contain a "C" language set of macros. The name of the "C" language subroutine containing these macros is "structures". The subroutine is used as an "includes" statement in three of the eleven "C" routines used in the Ascent/Descent process. Basically, the macros set up structured constructs for the "open" and "close" bracket ({, }) used in "C" language. Examples are a "begin" for a "{" and an "end_program" for a "}". These constructs are used in place of the brackets in the subroutine by using the "includes" statement.

Each "C" routine that uses these constructs has the following statement in the first several lines of the subroutine:

```
#include </users/Adheaven/MACROS/structures>
```

By use of this statement, the file "structures" is inserted as if it was part of the code of the "C" routine. The "structures" file contains a series of define statements that allow replacement of the brackets with the structured construct.

For the Ascent/Descent process, this routine is not used. This "C" routine is required only for recompilation of the three "C" routines:

CDCOUT/cdcout.c
FICHOUT/ebcdic.c
UNVOUT/unvout.c

Upon compilation of these "C" routines, the file "/users/Adheaven/MACROS/structures" must be available in the UNIX directory tree. After compilation of the "C" routines, this sub-directory is not used for any operational activity.

47.4 UNVOUT

UNVOUT is a "C" subroutine used in HP2UN and HPNAV2UNV programs. It is the foreign format writer for the tape that coverts the HP format to the UNIVAC format. It is linked with the HP2UN and HPNAV2UNV programs as a separate subroutine and called by the main programs. It is not used independently. It has it's own directory since a change in the routine affects both of the main programs.

UNVOUT is never executed by its self but is linked to other programs.

48.0 OUTPUT QA

When building the tapes to deliver the Ascent/Descent BET, it is desirable to know if there are any errors on the tape. A quality assurance program has been developed which reads back the BET tape meant for the Univac machine. The program computes rotation angles based on the quaternions. It also computes delta time and the position difference divided by velocity. The program then plots these values as they are computed. It also determines if they are within a predefined range.

The program is interactive. It also gets input from the BET tape.

48.1 EXECUTION PROCEDURE

To run the output QA program, the UNIVAC version of the final product tape must be mounted on the tape drive, then type

```
opchk.x
```

and execute.

48.2 SAMPLE INPUT

After initiation of program execution, the program will prompt the user for two pieces of information. The first prompt is

```
enter device
```

to which the user may respond with

```
/dev/tty1
/dev/tty2
    .
    .
```

/dev/tty7
or /dev/console

This query asks the user which of the eight terminals he/she is seated.

The second prompt is

ENTER INPUT TAPE UNIT (0 or 1)

which asks the user to state which tape unit is being used. User response may be 0 or 1.

48.3 SAMPLE OUTPUT

The program creates a file called VIEW and a plot on the screen.

The file VIEW consist of a printout of the first record on the tape, any values which were found to be beyond predefined limits, and the last record on the tape

The plot contains a body axis view of the shuttle as well as the values of the angular distance, position difference divided by velocity, and the angular rate of separation. A sample is:

FLT
61C
1986
12
BET OUTPUT PRODUCTS
TIME 564860.0000
STOP TIME
568800.0000
PER SECOND
COMMENTS

DESCENT
START

DATA RATE 1

LAUNCHED 09 JAN
1986

1

get: 521960.0000 gmt: date 18/1986 12:54:20.0000 sgmt: day 18
12:54:20.0000 pimu 4

```
                     x         y          z          xd         yd         zd
xdd     ydd     zdd
  2  m50nb     19182097  -2287947 -10503956    3530.04   25054.96    1043.56
.00      .00     .00
  3  m50cg     19182104  -2287902 -10503923    3530.02   25054.98    1043.54
.01      .00     .00

  4  gtofdnb   14280558  13063434 -10437097  -15722.87   17987.94    1056.36
.00      .00     .00
  5  gtofdnb  wind rel vel + total ac         -15722.87   17987.94    1056.36
-16.05  -14.79    13.86
  6  gtofdnb grav acc
-18.90  -17.29    13.86

  7  gtofdcg   14280558  13063434 -10437097  -15722.87   17987.94    1056.36
.00      .00     .00
  8  gtogdcg wind rel vel                     -15722.87   17987.94    1056.36

  9  landfld   -6563690  -1783877  41821553   15933.70   16640.90    6410.01
.00      .00     .00

 10  topdetic                                   1186.06   23884.78      29.20
.00      .00     .00
 11  topdetic velu + accu                           .25        .37       1.65
.25      .37    1.65
 12  topdetic  wind rel vel                     1186.06   23884.78      29.20

 13  bodynb                                   -19458.65   11939.30    7120.73
.00      .00     .00
 14  bodynb  velu + accu                          24.09      35.89      39.57
```

```
.00     .00     .00
 15  bodynb wind vector                               .00       .00       .00
 16  bodynb wind vectoru                              .00       .00       .00
 17  bodynb wind rel vel                         -19458.65  11939.30   7120.73
 18  bodynb wind rel velu                            24.09     35.89     39.57

 19  plumnb       -9999     -9999     -9999  -9999.00  -9999.00  -9999.00-
9999.00-9999.00-9999.00
 20  plumnbu      -9999     -9999     -9999  -9999.00  -9999.00  -9999.00-
9999.00-9999.00-9999.00
 21  plumnb wind rel vel                      -9999.00  -9999.00  -9999.00
 22  plumnb wind rel velu                     -9999.00  -9999.00  -9999.00

 23  plumcg       -9999     -9999     -9999  -9999.00  -9999.00  -9999.00-
9999.00-9999.00-9999.00
 24  plumcg wind rel vel                      -9999.00  -9999.00  -9999.00

 25  lat -28.489595   lon   42.451356   h  1079223   hd     -29.20   delta
-28.336474
 26  rs    42371058   s      59136996   hu     404   hdu      1.65

    1 quaternion           direction cosines
pitch      yaw       roll
 27  q1   .54815342   -.06049238  -.36984357   .92712265  euler    158.375
28.965     8.403
 28  q2   .41143851   -.78694542   .58906148   .18363956  euleru
.113       .099      .113
 29  q3  -.70289300   -.61405015  -.71848613  -.32668043  eulerd
.059      -.038      .022
 30  q4   .19023044                                       eulerdu
.113       .099      .113

 31  alpha   159.900    q        .102E-01     eas       1.7    visc
.900E+00    temp        612.3
 32  alphau     .115    qu       .797E-03     easu       .1    viscu
.364E+00    tempu       142.2
```

33 betap 148.468 qalpha .163E+01 mach 19.799 l
.0003 press .412E-04
34 betapu .104 qbeta .306E+00 machu 2.299 d/m
-.0003 pressu .733E-05
35 bank 115.451 lod
-23.2551 dens .357E-10
36 beta 29.951
37 betau .099

yaw
pitch roll
38 topodetic euler angles -123.570
18.895 177.670
39 topodetic euler angle rates -.047
.075 .022

x
y z
40 inertial body angular rates .022
-.008 -.034
41 inertial body angular rate uncertainties .099
.099 .099

42 inertial body angular accelerations -.026
.008 .005
43 inertial body angular acceleration uncertainties .099
.099 .099

44 center of mass contact accelerations -body coordinates .001
-.003 .008
45 center of mass contact acceleration uncertainties .007
.097 .097
46 center of mass in body axis coordinates -56.084
.033 3.892
no. = 508 time = 522467.0000 delta time = 1.00
delta delta time = .0000
delta position = .00000

angular separation = 6.26674 angular distance = -3.13229

no. = 509 time = 522468.0000 delta time = 1.00
delta delta time = .0000
delta position = .00000
angular separation = -6.26659 angular distance = 3.13245

no. = 3198 time = 525157.0000 delta time = 1.00
delta delta time = .0000
delta position = .00150
angular separation = 6.11663 angular distance = -3.04897

no. = 3199 time = 525158.0000 delta time = 1.00
delta delta time = .0000
delta position = .00149
angular separation = -6.11320 angular distance = 3.04326

no. = 3372 time = 525331.0000 delta time = 1.00
delta delta time = .0000
delta position = .00165
angular separation = 6.10784 angular distance = -3.04462

no. = 3373 time = 525332.0000 delta time = 1.00
delta delta time = .0000
delta position = .00166
angular separation = -6.14266 angular distance = 3.05796

no. = 3402 time = 525361.0000 delta time = 1.00
delta delta time = .0000
delta position = .00180

angular separation =   6.26400   angular distance = -3.13047

no. =   3403   time =   525362.0000   delta time =   1.00
delta delta time =   .0000
delta position =   .00181
angular separation = -6.26310   angular distance =   3.13103

no. =   3461   time =   525420.0000   delta time =   1.00
delta delta time =   .0000
delta position =   .00231
angular separation =   6.26248   angular distance = -3.12963

no. =   3462   time =   525421.0000   delta time =   1.00
delta delta time =   .0000
delta position =   .00233
angular separation = -6.26514   angular distance =   3.13143

no. =   3468   time =   525427.0000   delta time =   1.00
delta delta time =   .0000
delta position =   .00238
angular separation =   6.26297   angular distance = -3.12933

no. =   3469   time =   525428.0000   delta time =   1.00
delta delta time =   .0000
delta position =   .00238
angular separation = -6.25759   angular distance =   3.12875

no. =   3471   time =   525430.0000   delta time =   1.00
delta delta time =   .0000
delta position =   .00240

angular separation = 6.26120 angular distance = -3.12950

no. = 3472 time = 525431.0000 delta time = 1.00
delta delta time = .0000
delta position = .00243
angular separation = -6.25839 angular distance = 3.12679

no. = 3483 time = 525442.0000 delta time = 1.00
delta delta time = .0000
delta position = .00256
angular separation = 6.22436 angular distance = -3.08965

no. = 3484 time = 525443.0000 delta time = 1.00
delta delta time = .0000
delta position = .00253
angular separation = -6.13182 angular distance = 3.06516

no. = 3714 time = 525673.0000 delta time = 1.00
delta delta time = .0000
delta position = .00332
angular separation = 6.15740 angular distance = -3.07872

no. = 3715 time = 525674.0000 delta time = 1.00
delta delta time = .0000
delta position = .00368
angular separation = -6.16595 angular distance = 3.04838

no. = 3942 time = -9999.0000 delta time = *******
delta delta time = .0000
delta position = *********

```
angular separation =   -.00028  angular distance =  -2.62569


no. =    3943  time =    -9999.0000  delta time =     .00
delta delta time =          .0000
delta position =  -1.00000
angular separation =    .00000  angular distance =    .00000


no. =    3944  time =    -9999.0000  delta time =     .00
delta delta time =          .0000
delta position =  -1.00000
angular separation =    .00000  angular distance =    .00000


1  get: 525900.0000  gmt: date  18/1986  14: 0:  .0000  sgmt: day  18  14:
0:  .0000  pimu 2
                 x          y          z          xd         yd         zd
xdd      ydd      zdd
  2  m50nb     -14939385  -8415625  11958772    613.69  -1092.43     -2.12
-22.92  -12.92   18.45
  3  m50cg     -14939346  -8415657  11958796    613.70  -1092.41     -2.11
-22.91  -12.91   18.45

  4  gtofdnb    -8039345 -15186344  11906472       .00        .00       .00
-12.33  -23.30   18.37
  5  gtofdnb  wind rel vel + total ac            -1.45        .77       .00
-.09     -.17     -.01
  6  gtofdnb grav acc
12.37   23.37  -18.39

  7  gtofdcg    -8039345 -15186344  11906472       .00        .00       .00
-12.33  -23.30   18.37
  8  gtogdcg wind rel vel                        -1.45        .77       .00

  9  landfld       11789         0        -20       .00        .00       .00
```

```
.02     -.02   -32.14

 10  topdetic                                                 .00       .00       .00
-.02      .01   -32.14
 11  topdetic velu + accu                                     .00       .00       .00
.00      .00      .00
 12  topdetic  wind rel vel                                   .00     -1.64       .00

 13  bodynb                                                   .00       .00       .00
-2.02     -.04   -32.07
 14  bodynb  velu + accu                                      .00       .00       .00
.56      .49      .62
 15  bodynb wind vector                                     -1.38      -.88       .09
 16  bodynb wind vectoru                                     5.55      3.54      1.67
 17  bodynb wind rel vel                                     1.38       .88      -.09
 18  bodynb wind rel velu                                    5.55      3.54      1.67

 19  plumnb        -9999     -9999     -9999  -9999.00  -9999.00  -9999.00-
9999.00-9999.00-9999.00
 20  plumnbu       -9999     -9999     -9999  -9999.00  -9999.00  -9999.00-
9999.00-9999.00-9999.00
 21  plumnb wind rel vel                      -9999.00  -9999.00  -9999.00
 22  plumnb wind rel velu                     -9999.00  -9999.00  -9999.00

 23  plumcg        -9999     -9999     -9999  -9999.00  -9999.00  -9999.00-
9999.00-9999.00-9999.00
 24  plumcg wind rel vel                      -9999.00  -9999.00  -9999.00

 25  lat  34.899228    lon  242.104156    h     2120    hd         .00
delta  34.718895
 26  rs         11789    s          11789    hu        0    hdu        .00

     1 quaternion               direction cosines
pitch      yaw        roll
 27  ql   .36073153   -.63556175   .16342746   .75455466  euler     -4.166
-32.222    -2.024
```

28 q2 -.22823648 .61187326 .70263641 .36319855 euleru .923
19.936 1.721
29 q3 -.84922963 -.47082096 .69252692 -.54656572 eulerd
.212 4.208 .380
30 q4 -.31078916 eulerdu .935
20.204 1.744

31 alpha -3.000 q .316E-02 eas 1.0 visc .119E-
05 temp 494.8
32 alphau 67.830 qu .252E-01 easu 3.8 viscu .532E-
05 tempu .2
33 betap 32.770 qalpha -.948E-02 mach .002 1
.9985 press .197E+04
34 betapu 20.057 qbeta .103E+00 machu .006 d/m
.3054 pressu .395E+01
35 bank -1.177 lod
105.1791 dens .233E-02
36 beta 32.734
37 betau 19.965

yaw
pitch roll
38 topodetic euler angles -122.260
-3.620 .047
39 topodetic euler angle rates .013
.008 .006

x
y z
40 inertial body angular rates .006
.016 -.017
41 inertial body angular rate uncertainties .099
.099 .099

42 inertial body angular accelerations .005
.009 -.012
43 inertial body angular acceleration uncertainties .099

.099 .099

44 center of mass contact accelerations -body coordinates -2.023
-.032 -32.063
45 center of mass contact acceleration uncertainties .561
.493 .624
46 center of mass in body axis coordinates -55.481
.033 4.478

The file VIEW contains the first record read from the BET tape, any data which was beyond reasonable checks, and the last record read from the BET tape.

The plot consists of the X, Y, and Z body axis coordinates as well as the angular distance, position difference divided by velocity, and the angular separation rate.

APPENDIX A

INPUTS FOR MISSION STS-61C

MAIN MENU

a. START/STOP TIME
b. REFSMATS
c. CGTABLE
d. SPECIAL EVENT TIMES
e. S-BAND DATA
f. DEWPOINTS
g. DEORBIT VECTOR
h. RADAR DATA DELETION INTERVALS
i. SHUTTLE IMU MATRICES
j. RARELY CHANGED VARIABLES
k. RADAR MANUAL SELECTIONS
l. IMU SELECTION FOR BEA
m. RUNWAY DATA
q. QUIT

Menu Selection a: Start/Stop Time

```
START TIME (seconds from midnight day of launch)..   564860.0
STOP TIME  (seconds from midnight day of launch)..   568800.0
MISSION NUMBER....................................   61C
DAY OF LAUNCH (day of the year)...................    12
LAUNCH DATE (day,month,year)......................   09 JAN 1986
TIME OF SRB IGNITION (seconds from midnight)......   42900.0
SHUTTLE MASS (kg).................................   96426.0
DRAG COEFFICIENT..................................   75.
ET-UT (ephemeris time - universal time: seconds)..   55.53
FILTER OPTIONS:
  FORWARD ONLY OR FORWARD/BACKWARD (fo/fb)........   fo
  USE UPDATE VECTOR? (y/n)........................   n
  USE C-BAND 1 DATA? (y/n)........................   y
  USE C-BAND 2 DATA? (y/n)........................   y
  USE C-BAND 3 DATA? (y/n)........................   y
  USE S-BAND DATA? (y/n)..........................   y
  USE TDRS DATA? (y/n)............................   n
  USE MSBLS RANGE DATA? (y/n).....................   n
  USE MSBLS AZIMUTH DATA? (y/n)...................   n
  USE MSBLS WEDGE DATA? (y/n).....................   n
------------------------------------------------------------------------
q = quit              < = tab left          /i = insert line
a = ABORT             > = tab right         /d = delete line
------------------------------------------------------------------------
```

Menu Selection b: REFSMATS

REFSMATS

MU1

397538661956787d0	0.450351297855376900d0	0.648788988590240479d0
7315282821655273d0	-0.554566204547882080d0	0.741680145263671875d0
8130855560030273d0	-0.699742794036865234d0	-0.170245051383972168d0

MU2

444071292877197d0	-0.731741309165960000d0	0.614220976829528809d0
084608316421509d-1	0.627772152424000000d0	0.776172459125518799d0
548252582550049d0	-0.265436947345730000d0	0.142438948154449463d0

MU3

404318332672119d0	0.125068664550781250d0	0.822796225547800000d0
6298637390136 72d0	-0.229574143886566162d0	0.567626774311065674d0
3850727081298 83d0	0.965222001075745000d0	0.283938609063625336d-1

---

q = quit　　　< = tab left　　　/i = insert line

a = ABORT　　　> = tab right　　　/d = delete line

Menu Selection c: CG Table

CGTABLE

For Ascent time is in seconds from SRB ignition

For descent time is in seconds from midnight day of launch

IE	X	Y	Z
0.	1092.200	0.4000	375.300
4.4	1081.700	0.4000	371.400
7.8	1085.300	0.4000	371.400
9.4	1083.500	0.4000	370.700
6.8	1085.000	0.4000	368.200
7.2	1085.000	0.4000	368.200
.	-9999.	-9999.	-9999.
	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000

= quit	< = tab left	/i = insert line
= ABORT	> = tab right	/d = delete line

Menu Selection d: Special Event Times

```
                    SPECIAL EVENT TIMES

     (DAYS REFERS TO THE NUMBER OF DAYS SINCE LAUNCH)

HOURS  MINUTES  SECONDS          SPECIAL EVENT DESCRIPTION

 12      54     30.000d0  DEORBIT BURN IGNITION
 12      58     22.000d0  DEORBIT BURN CUTOFF
 13      28      3.000d0  ENTRY INTERFACE (400000 FT )
 13      45     32.000d0  BLACKOUT END
 13      52     46.000d0  TAEM
 13      58     51.000d0  MLG CONTACT
 13      59      7.000d0  NLG CONTACT
 13      59     50.000d0  WHEEL STOP
 99      99     99.d0

----------------------------------------------------------------------
 = quit                  < = tab left                 /i - insert line
 = ABORT                 > = tab right                /d = delete line
----------------------------------------------------------------------
```

Menu Selection e: S-Band Data

S-BAND FREQUENCIES

STATION ID	FREQUENCY (HZ)
BDAS	2106384288.0
GDSS	2106406288.0
GDXS	2106406288.0
GWMS	2106406288.0
HAWS	2106406288.0
MLXS	2106423296.0
MILS	2106422288.0
MADS	2106406300.0
ORRS	2106406300.0
MAXS	2106406300.0
ACNS	2106406300.0
AGOS	2106406300.0
BLXS	2106406300.0
CANS	2106406300.0
VANS	2106406300.0

TRANSPONDER DELAY = 137.0 METERS

= quit	< = tab left	/i = insert line
= ABORT	> = tab right	/d = delete line

C-5

Menu Selection f: Dewpoints

DEWPOINTS

(ENTER AN INTEGER BETWEEN 1 AND 12)... 1

STATIONS WHOSE DATA IS CORRECTED FOR REFRACTION ONSITE

CNVC	GBIC	GTKC	KPTC	MLAC	PATC	PAFC
MLMC	CNOC	KMTC				

N ID	DRY BULB TEMP (DEG. F)	WET BULB TEMP (DEG. F)	PRESSURE (MB)
	60.0	56.0	1009.0
	56.0	51.0	945.0
	50.0	46.0	937.0
	47.5	43.0	934.3
	59.0	56.0	988.5
	-9999.	-9999.	-9999.

q = quit　　< = tab left　　/i = insert line
a = ABORT　　> = tab right　　/d = delete line

Menu Selection g: Deorbit Vector

```
                DEORBIT VECTOR

   VECTOR IS TIME TAGGED AT FILTER START TIME

              X =   5846678.8
              Y =   -697302.0
              Z = -3201586.8
           XDOT =       1075.8247
           YDOT =       7636.811
           ZDOT =        318.1832
--------------------------------------------------------------------------------
/q = quit                  < = tab left                 /i = insert line
/a = ABORT                 > = tab right                /d = delete line
--------------------------------------------------------------------------------
```

Menu Selection h: Radar Data Deletion Intervals

```
                RADAR DATA DELETION INTERVALS
       (units are seconds from midnight day of launch)
1                     START                  STOP
                     0.d0                    0.d0
                     0.d0                    0.d0
                     0.d0                    0.d0
                     0.d0                    0.d0
                     0.d0                    0.d0
                     0.d0                    0.d0
                     0.d0                    0.d0
                     0.d0                    0.d0
2                     START                  STOP
                     0.d0                    0.d0
                     0.d0                    0.d0
                     0.d0                    0.d0
                     0.d0                    0.d0
                     0.d0                    0.d0
                     0.d0                    0.d0
3                     START                  STOP
                     0.d0                    0.d0
--------------------------------------------------------------------
 = quit                 < = tab left              /i = insert line
 = ABORT                > = tab right             /d = delete line
--------------------------------------------------------------------
```

Menu Selection h: Radar Data Deletion Intervals (cont.)

```
                    0.d0              0.d0
                    0.d0              0.d0
                    0.d0              0.d0
                    0.d0              0.d0
                    0.d0              0.d0
                     START             STOP
                    0.d0              0.d0
                    0.d0              0.d0
                    0.d0              0.d0
                    0.d0              0.d0
                    0.d0              0.d0
                     START             STOP
                    0.d0              0.d0
                    0.d0              0.d0
                    0.d0              0.d0
                    0.d0              0.d0
                    0.d0              0.d0
ANGE                 START             STOP
                    0.d0              0.d0
                    0.d0              0.d0
------------------------------------------------------------------
 = quit                < = tab left           /i = insert line
 = ABORT               > = tab right          /d = delete line
------------------------------------------------------------------
```

Menu Selection h: Radar Data Deletion Intervals (cont.)

AZIMUTH	0.0d0	0.0d0
	START	STOP
	0.d0	0.d0
	0.d0	0.d0
WEDGE 1	0.d0	0.d0
	START	STOP
	0.d0	0.d0
	0.d0	0.d0
	0.d0	0.d0

= quit	< = tab left	/i = insert line
= ABORT	> = tab right	/d = delete line

Menu Selection i: Shuttle IMU Matrices

SHUTTLE IMU MATRICES

NAV BASE TO CASE TRANSFORMATIONS

.0d0	0.0d0	0.0d0
.0d0	0.0d0	0.0d0
.0d0	0.0d0	0.0d0
.0d0	0.0d0	0.0d0
.0d0	0.0d0	0.0d0
.0d0	0.0d0	0.0d0
.0d0	0.0d0	0.0d0
.0d0	0.0d0	0.0d0
.0d0	0.0d0	0.0d0

= quit	< = tab left	/i = insert line
= ABORT	> = tab right	/d = delete line

Menu Selection i: Shuttle IMU Matrices (cont.)

```
GE TO BODY TRANSFORMATION
.0d0                    0.0d0                    0.0d0
.0d0                    0.0d0                    0.0d0
.0d0                    0.0d0                    0.0d0

IMBAL AZIMUTH OFFSET (RADIANS):
-1.............................. 0.0000000000000
-2.............................. 0.0000000000000
-3.............................. 0.0000000000000

IMBAL PITCH OFFSET (RADIANS):
-1.............................. 0.0000000000000
-2.............................. 0.0000000000000
-3.............................. 0.0000000000000

------------------------------------------------------------------------
 = quit                 < = tab left              /i = insert line
 = ABORT                > = tab right             /d = delete line
------------------------------------------------------------------------
```

Menu Selection j: Rarely Changed Variables

```
                         RARELY CHANGED VARIABLES

CORRECTION IN SECONDS TO PRODUCE ASTRONOMIC
LONGITUDE FROM GEODETIC LONGITUDE
ASCENT - LAUNCH PAD; DESCENT - RUNWAY.................. 0.0d0

H: GEODETIC HEIGHT OF THE LAUNCH PAD/RUNWAY IN FEET.... -113.0d0

CORRECTION IN SECONDS TO PRODUCE ASTRONOMIC
LATITUDE FROM GEODETIC LATITUDE
ASCENT - LAUNCH PAD; DESCENT - RUNWAY.................. 0.d0

: REFRACTION CONSTANTS FOR CALIFORNIA COASTAL STATIONS
  CALABC(1)............................................ 20285.d0
  CALABC(2)............................................ 40.0d0
  CALABC(3)............................................ 0.0d0

  STANDARD DEVIATIONS OF THE CG LOCATION (FEET)
  X.................................................... 1.0d0
  Y.................................................... 1.0d0
---------------------------------------------------------------------------
q = quit                 < = tab left                 /i = insert line
a = ABORT                > = tab right                /d = delete line
---------------------------------------------------------------------------
```

Menu Selection j: Rarely Changed Variables (cont.)

```
 Z.................................................... 1.0d0
S: AXIS DIRECTIONS FOR CG INPUT COORDINATES
   X.................................................. -1.d0
   Y..................................................  1.d0
   Z.................................................. -1.d0
: CONVERSION CONSTANT FOR THE CENTER OF GRAVITY TABLE
  ASCENT - 1 (FEET) ; DESCENT - 12 (INCHES)............ 12.d0
: REFERENCE POINT FOR CONVERTING THE CENTER OF GRAVITY
  TABLE FROM STRUCTURAL TO BODY AXIS COORDINATES
  X.................................................... 419.187d0
  Y.................................................... 0.0d0
  Z.................................................... 422.d0
 LOGICAL FLAG
 TRUE  - INPUT COVARIANCE MATRIX
 FALSE - INPUT STANDARD DEVIATIONS..................... FALSE
---------------------------------------------------------------------
q = quit                 < = tab left              /i = insert line
 = ABORT                 > = tab right             /d = delete line
---------------------------------------------------------------------
```

Menu Selection j: Rarely Changed Variables (cont.)

```
HE COVARIANCE OF THE INITIAL POSITION AND VELOCITY
N UVW COORDINATES:

2.00d0     0.0000d0    0.0000d0    0.0000d0    -.9400d0     0.0000d0
0000d0     1000.0d0    0.0000d0    -0.990d0    0.0000d0     0.0000d0
0000d0     0.0000d0    66.000d0    0.0000d0    0.0000d0     0.0000d0
0000d0     0.0000d0    0.0000d0    1.1500d0    0.0000d0     0.0000d0
0000d0     0.0000d0    0.0000d0    0.0000d0    0.1200d0     0.0000d0
0000d0     0.0000d0    0.0000d0    0.0000d0    0.0000d0     0.0800d0

LOGICAL PRINT FLAG.................................. FALSE

 ERROR BETWEEN ONBOARD AND GROUND BASED CLOCKS
 AT EPOCH (SECONDS).................................. 0.0d0

 ONBOARD CLOCK DRIFT RATE (SECONDS/SECOND)............ 0.0d0
 (N.B. : DRFTRT AND REFTM ARE RELATED)

: NO. OF CYCLES BETWEEN PRINTOUTS IN LRBET5 (P(2)).... 10.0

---------------------------------------------------------------------
 = quit                  < = tab left              /i = insert line
 = ABORT                 > = tab right             /d = delete line
---------------------------------------------------------------------
```

Menu Selection j: Rarely Changed Variables (cont.)

```
: EQUATORIAL RADIUS OF THE EARTH (METERS).............. 6378166.0d0

 HEIGHT OF MEAN SEA LEVEL WITH RESPECT TO THE
 REFERENCE ELLIPSOID AT THE LAUNCH SITE (ASCENT)
 OR RUNWAY (DESCENT).................................... -208.0d0

: GMT SECONDS FROM MIDNIGHT DAY OF LAUNCH ON THE
   ONBOARD CLOCK CORRECTED WITH DELTTE.................. 0.0d0

IDANCE REFERENCE RELEASE TIME IN SECONDS FROM
IDNIGHT DAY OF LAUNCH. THIS IS THE TIME AT WHICH THE
U'S ARE RELEASED (NORMALLY AT SRB IGNITION)............ 0.0d0

RTH GRAVITATIONAL HARMONIC.............................. 0.001082627d0

RTH GRAVITATIONAL CONSTANT (METERS**3/SEC**2)......... 398600470000000.0

: POSITION OF THE NAV BASE RELATIVE TO THE MAIN
  LANDING GEAR IN BODY AXIS COORDINATES (METERS)
    X................................................... 19.128d0
------------------------------------------------------------------------
 = quit                   < = tab left                 /i = insert line
 = ABORT                  > = tab right                /d = delete line
------------------------------------------------------------------------
```

Menu Selection j: Rarely Changed Variables (cont.)

```
    Y.............................................. 0.0d0
    Z.............................................. -6.388d0

EFERENCE POSITION OF THE NAV BASE IN STRUCTURE
OORDINATES (FEET)
    X.............................................. 34.93225d0
    Y.............................................. 0.0d0
    Z.............................................. 35.16670d0

 ONBOARD CLOCK BIAS (SECONDS)...................... 0.0d0

 PRINT FLAG IN LRBET5.............................. 0.d0

 EARTH ROTATION RATE (RADIANS/SEC)................. 7.2921151464592d-5

TIME AT WHICH THE ONBOARD CLOCKS BEGAN TO DRIFT....... 0.0d0
(N.B. : REFTM AND DRFTRT ARE RELATED)

 RECIPROCAL OF THE EARTH ELLIPTICITY............... 298.3d0

-----------------------------------------------------------------------
 = quit                    < = tab left                /i = insert line
 = ABORT                   > = tab right               /d = delete line
-----------------------------------------------------------------------
```

Menu Selection j: Rarely Changed Variables (cont.)

```
SCALING RADIUS FOR GRAVITATION (METERS)............... 6378139.0d0

NUMERATOR AND DENOMINATOR OF S-BAND TURNAROUND RATIO
NUMERATOR............................................. 240.0d0
DENOMINATOR........................................... 221.0d0

A' COEFFICIENTS FOR SCALE HEIGHT
SHA(1)................................................ 17590.0d0
SHA(2)................................................ 18588.0d0
SHA(3)................................................ 21273.0d0

B' COEFFICIENTS FOR SCALE HEIGHT
SHB(1)................................................ 30.55d0
SHB(2)................................................ 40.814d0
SHB(3)................................................ 60.227d0

C' COEFFICIENTS FOR SCALE HEIGHT
SHC(1)................................................ 0.0d0
SHC(2)................................................ 1500.0d0
SHC(3)................................................ 3000.0d0
---------------------------------------------------------------------------
 = quit                  < = tab left              /i = insert line
 = ABORT                 > = tab right             /d = delete line
---------------------------------------------------------------------------
```

Menu Selection j: Rarely Changed Variables (cont.)

```
: ALTITUDE BREAK POINTS FOR SCALE HEIGHT
 SHBREAK(1)........................................ 1000.0d0
 SHBREAK(2)........................................ 2500.0d0
```

```
-------------------------------------------------------------------------
= quit                  < = tab left                /i = insert line
= ABORT                 > = tab right               /d = delete line
-------------------------------------------------------------------------
```

Menu Selection k: Radar Manual Selections

MANUAL RADAR SELECTION

(Set Low rate to 1 if Low rate data)

1

STATION ID	START TIME	STOP TIME	LOW RATE
KPTC	567390.1d0	567475.1d0	0
VDFC	568024.1d0	568062.1d0	0
VDBC	568062.11d0	568294.1d0	0
FRCC	568294.11d0	568724.1d0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0

= quit	< = tab left	/i = insert line
= ABORT	> = tab right	/d = delete line

Menu Selection k: Radar Manual Selections (cont.)

2

STATION ID	START TIME	STOP TIME	LOW RATE
SNFC	568047.1d0	568099.1d0	0
VDFC	568099.11d0	568218.1d0	0
SNFC	568218.11d0	568315.1d0	0
EFFC	568315.11d0	568722.1d0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0

= quit < = tab left /i = insert line
= ABORT > = tab right /d = delete line

Menu Selection k: Radar Manual Selections (cont.)

STATION ID	START TIME	STOP TIME	LOW RATE
VDFC	568062.1d0	568070.1d0	0
SNFC	568099.11d0	568218.1d0	0
VDFC	568218.11d0	568294.1d0	0
VDBC	568294.11d0	568371.1d0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0

= quit	< = tab left	/i = insert line
= ABORT	> = tab right	/d = delete line

Menu Selection k: Radar Manual Selections (cont.)

STATION ID	START TIME	STOP TIME	LOW RATE
GWMS	566399.1d0	566769.1d0	1
GDXS	568192.1d0	568707.1d0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0
	000000.0	000000.0	0

= quit
= ABORT

< = tab left
> = tab right

/i = insert line
/d = delete line

Menu Selection 1: IMU Selection for BEA

IMU SELECTION FOR BEST ESTIMATE OF ATTITUDE

TIME	OPTION	TOLERANCE
566830.0d0	7	0.0500d0
567000.0d0	7	0.0500d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0
-9999.0d0	0	-9999.0d0

= quit
= ABORT

< = tab left
> = tab right

/i = insert line
/d = delete line

Menu Selection m: Runway Data

```
                    RUNWAY DATA

     ROLLOUT VECTOR IS TIME TAGGED AT FILTER STOP TIME
 LATERAL DISPLACEMENT IS MEASURED POSITIVE TO THE RIGHT OF
                 RUNWAY CENTERLINE

RUNWAY ID..................................... edw22

TOUCHDOWN:
  DISTANCE TO RUNWAY THRESHOLD................ 572.0
  LATERAL DISPLACEMENT OF MAIN GEAR MIDPOINT..... 0.0

ROLLOUT:
  DISTANCE TO RUNWAY THRESHOLD................ 11727.0
  LEFT MAIN LATERAL DISPLACEMENT.............. -11.347
  RIGHT MAIN LATERAL DISPLACEMENT............. 11.347

----------------------------------------------------------------------
= quit                   < = tab left               /i = insert line
= ABORT                  > = tab right              /d = delete line
----------------------------------------------------------------------
```

APPENDIX B

DEFINITION OF EACH DOUBLE PRECISION WORD
IN THE OUTPUT PRODUCT

dp word	definition

(1) Ground elapsed time - Time in seconds from launch time.

(2) GMT day - Greenwich Mean Time current day from Dec 31.

(3) GMT hour - Greenwich Mean Time current hours from midnight.

(4) GMT minutes - Greenwich Mean Time current minutes from midnight.

(5) GMT seconds - Greenwich Mean Time current seconds from midnight.

(6) Onboard clock day - Current day from Dec 31 of onboard clock.

(7) Onboard clock hour - Current hours from midnight of onboard clock.

(8) Onboard clock minutes - Current minutes from midnight of onboard clock.

(9) Onboard clock seconds - Current seconds from midnight of onboard clock.

(10) GMT year - Greenwich Mean Time, current year.

(11) to (13) Mean of 50 Position - The position of the nav base relative to the center of the earth in Mean of 50 coordinates (X,Y,Z) measured in feet.

(14) to (16) Mean of 50 Velocity - The inertial velocity of the nav base relative to the center of the earth in Mean of 50 coordinates $(\dot{X},\dot{Y},\dot{Z})$ measured in feet/second.

(17) to (19) Mean of 50 Acceleration - The inertial acceleration of the nav base relative to the center of the earth in Mean of 50 coordinates $(\ddot{X},\ddot{Y},\ddot{Z})$ measured in feet/second squared.

(20) to (22) Mean of 50 Position of the CG - The position of the CG relative to the center of the earth in Mean of 50 coordinates (X,Y,Z)

measured in feet.

(23) to (25) Mean of 50 Velocity of the CG - The inertial velocity of the CG relative to the center of the earth in Mean of 50 coordinates $(\dot{X},\dot{Y},\dot{Z})$ measured in feet/second.

(26) to (28) Mean of 50 Acceleration of the CG - The inertial acceleration of the CG relative to the center of the earth in Mean of 50 coordinates $(\ddot{X},\ddot{Y},\ddot{Z})$ measured in feet/second squared.

(29) to (31) Earth fixed Position - The position of the nav base in earth fixed Greenwich true of date coordinates (X,Y,Z) measured in feet.

(32) to (34) Earth fixed Velocity - The inertial velocity of the nav base in earth fixed Greenwich true of date coordinates $(\dot{X},\dot{Y},\dot{Z})$ measured in feet/second.

(35) to (37) Earth fixed Acceleration - The contact acceleration of the nav base in earth fixed Greenwich true of date coordinates $(\ddot{X},\ddot{Y},\ddot{Z})$ measured in feet/second squared.

(38) to (40) Earth fixed Total Acceleration - The total acceleration of the nav base in earth fixed Greenwich true of date coordinates $(\ddot{X},\ddot{Y},\ddot{Z})$ measured in feet/second squared.

(41) to (43) Gravitational Acceleration - The gravitational acceleration of the nav base in earth fixed Greenwich true of date coordinates $(\ddot{X},\ddot{Y},\ddot{Z})$ measured in feet/second squared.

(44) to (46) Wind Relative Velocity - The wind relative velocity of the nav base in earth fixed Greenwich true of date coordinates measured in feet/second.

(47) to (49) Earth fixed Position of the CG - The position of the CG in earth fixed Greenwich true of date coordinates measured in feet.

(50) to (52) Earth fixed Velocity of the CG - The inertial velocity CG in earth fixed Greenwich true of date coordinates measured in feet/second.

(53) to (55) Earth fixed Acceleration of the CG - The contact acceleration of the CG in earth fixed Greenwich true of date coordinates measured in feet/second squared.

(56) to (58) Wind Relative Velocity of the CG - The wind relative velocity of the CG in earth fixed Greenwich true of date coordinates measured in feet/second.

(59) to (61) Landing field Position - The position of the nav base relative to the runway expressed in runway coordinates measured in feet.

(62) to (64) Landing field Velocity - The inertial velocity of the nav base relative to the runway expressed in runway coordinates measured in feet/second.

(65) to (67) Landing field Acceleration - The contact acceleration of the nav base relative to the runway expressed in runway coordinates measured in feet/second squared.

(68) to (70) Topodetic Velocity - The velocity of the nav base as viewed in the rotating topodetic coordinates measured in feet/second.

(71) to (73) Topodetic Acceleration - The contact acceleration of the nav base as viewed in the rotating topodetic coordinates measured in feet/second squared.

(74) to (76) Topodetic Velocity Uncertainty - The uncertainty of the velocity of the nav base as viewed in the rotating topodetic coordinates measured in feet/second.

(77) to (79) Topodetic Acceleration Uncertainty - The uncertainty of the

contact acceleration of the nav base as viewed in the rotating topodetic coordinates measured in feet/second squared.

(80) to (82) Topodetic Velocity Wind relative - The wind relative velocity of the nav base as viewed in the rotating topodetic coordinates measured in feet/second.

(83) to (85) Earth fixed Velocity in body axis coordinates - The velocity of the nav base in earth fixed coordinates projected into body-axis coordinates measured in feet/second.

(86) to (88) Earth fixed Acceleration in body axis coordinates - The contact acceleration of the nav base in earth fixed coordinates projected into body-axis coordinates measured in feet/second squared.

(89) to (91) Wind Relative Vector in Body Axis Coordinates - The wind vector in earth fixed coordinates projected into the body-axis coordinates measured in feet/second.

(92) to (94) Earth fixed Velocity in body axis coordinates wind relative - The wind relative velocity of the nav base in earth fixed coordinates projected into body-axis coordinates measured in feet/second.

(95) to (97) Earth fixed Velocity Uncertainty in body axis coordinates - The velocity uncertainty of the nav base in earth fixed coordinates projected into body-axis coordinates measured in feet/second.

(98) to (100) Earth fixed Acceleration Uncertainty in body axis coordinates - The contact acceleration uncertainty of the nav base in earth fixed coordinates projected into body-axis coordinates measured in feet/second squared.

(101) to (103) Wind Relative Vector Uncertainty in Body Axis Coordinates - The wind vector uncertainty in earth fixed coordinates

projected into the body- axis coordinates measured in feet/second.

(104) to (106) Earth fixed Velocity Uncertainty in body axis coordinates wind relative - The wind relative velocity uncertainty of the nav base in earth fixed coordinates projected into body-axis coordinates measured in feet/second.

(107) to (110) M50 to Body Quaternion - The quaternion that transforms the Mean of 50 coordinates to body axis coordinates.

(111) Selected IMU Index - The index of the selected IMU

(112) to (114) Plumbline Position - The position of the nav base relative to the center of the earth in plumbline coordinates measured in feet.

(115) to (117) Plumbline Velocity - The inertial velocity of the nav base relative to the center of the earth in plumbline coordinates measured in feet/second.

(118) to (120) Plumbline Acceleration - The contact acceleration of the nav base relative to the center of the earth in plumbline coordinates measured in feet/second squared.

(121) to (123) Plumbline Position Uncertainty - The position uncertainty of the nav base relative to the center of the earth in plumbline coordinates measured in feet.

(124) to (126) Plumbline Velocity Uncertainty - The inertial velocity uncertainty of the nav base relative to the center of the earth in plumbline coordinates measured in feet/second.

(127) to (129) Plumbline Acceleration Uncertainty - The contact acceleration uncertainty of the nav base relative to the center of the earth in plumbline coordinates measured in feet/second

squared.

(130) to (132) Plumbline Wind Relative Velocity - The inertial wind relative velocity of the nav base relative to the center of the earth in plumbline coordinates measured in feet/second.

(133) to (135) Plumbline Wind Relative Velocity Uncertainty - The inertial wind relative velocity uncertainty of the nav base relative to the center of the earth in plumbline coordinates measured in feet/second.

(136) to (138) Plumbline Position of the CG - The position of the CG relative to the center of the earth in plumbline coordinates measured in feet.

(139) to (141) Plumbline Velocity of the CG - The inertial velocity of the CG relative to the center of the earth in plumbline coordinates measured in feet/second.

(142) to (144) Plumbline Acceleration of the CG - The contact acceleration of the CG relative to the center of the earth in plumbline coordinates measured in feet/second squared.

(145) to (147) Plumbline Wind Relative Velocity of the CG - The inertial wind relative velocity of the CG relative to the center of the earth in plumbline coordinates measured in feet/second.

(148) Yaw - The yaw of th body axis with respect to the LVLH system measured in degrees.

(149) Yaw Uncertainty - The yaw uncertainty of the body axis with respect to the LVLH system measured in degrees.

(150) Pitch - The pitch of the body axis with respect to the LVLH system measured in degrees.

(151) Pitch Uncertainty - The pitch uncertainty of the body axis with respect to the LVLH system measured in degrees.

(152) Roll - The roll of the body axis with respect to the LVLH system measured in degrees.

(153) Roll Uncertainty - The roll uncertainty of the body axis with respect to the LVLH system measured in degrees.

(154) Yaw Rate - The yaw rate of the body axis with respect to the LVLH system measured in degrees.

(155) Yaw Rate Uncertainty - The yaw rate uncertainty of the body axis with respect to the LVLH system measured in degrees.

(156) Pitch Rate - The pitch rate of the body axis with respect to the LVLH system measured in degrees.

(157) Pitch Rate Uncertainty - The pitch rate uncertainty of the body axis with respect to the LVLH system measured in degrees.

(158) Roll Rate - The roll rate of the body axis with respect to the LVLH system measured in degrees.

(159) Roll Rate Uncertainty - The roll rate uncertainty of the body axis with respect to the LVLH system measured in degrees.

(160) Bank Angle - Bank angle in degrees for the cg.

(161) Geodetic Longitude - The geodetic longitude of the nav base in degrees (plus is East).

(162) Geodetic Latitude - The geodetic latitude of the nav base in degrees (plus is North).

(163) Geodetic Altitude - The geodetic altitude of the nav base in feet.

(164) Geodetic Altitude Uncertainty - The geodetic altitude uncertainty of the nav base in feet.

(165) Geodetic Altitude Rate - The geodetic altitude rate of the nav base in feet/second.

(166) Geodetic Altitude Rate Uncertainty - The geodetic altitude rate uncertainty of the nav base in feet/second.

(167) Declination of the Nav Base - The declination of the nav base in degrees.

(168) Radius Vector Magnitude - The magnitude of the vector from the center of the earth to the nav base measured in feet.

(169) Velocity Magnitude - The Magnitude of the velocity of the nav base relative to the center of the earth measured in feet/second.

(170) Flight Path Angle - The flight path angle as seen in ECI coordinates in degrees.

(171) Azimuth Angle - The azimuth of the velocity vector as seen in the ECI coordinates in degrees measured positive CLOCKWISE from North.

(172) Slant Range - The slant range from the nav base to the launch site (on ascent) or the runway (on descent) measured in feet.

(173) to (181) M50 to body Transformation - The transformation matrix from Mean of 50 to body axis in radians/second squared. Matrix is a 3x3 by columns.

(182) Wind Relative Velocity Magnitude - The magnitude of the wind relative velocity of the CG in feet/second.

(183) Wind Relative Velocity Magnitude Uncertainty - The magnitude of the wind relative velocity uncertainty of the CG in feet/second.

(184) Wind Relative Flight Path Angle - The wind relative flight path angle as seen in ECI coordinates in degrees relative to the CG.

(185) Wind Relative Flight Path Angle Uncertainty - The wind relative flight path angle uncertainty as seen in ECI coordinates in degrees relative to the CG.

(186) Wind Relative Azimuth Angle - The wind relative azimuth of the velocity vector as seen in the ECI coordinates in degrees measured from the CG positive CLOCKWISE from North.

(187) Wind Relative Azimuth Angle Uncertainty - The wind relative azimuth uncertainty of the velocity vector as seen in the ECI coordinates in degrees measured from the CG positive CLOCKWISE from North.

(188) Surface Range - The surface range from the nav base to the launch site (on ascent) or the runway (on descent) measured in feet.

(189) Wind Relative Angle of Attack - The wind relative angle of attack in degrees for the CG

(190) Wind Relative Angle of Attack Uncertainty - The wind relative angle of attack uncertainty in degrees for the CG.

(191) Wind Relative Guidance Sideslip Angle - The wind relative guidance sideslip angle in degrees for the CG.

(192) Wind Relative Guidance Sideslip Angle Uncertainty - The wind relative guidance sideslip angle uncertainty in degrees for the CG.

(193) Wind Relative Dynamic Pressure - The wind relative dynamic pressure for the velocity of the CG in pounds per square foot.

wind relative velocity uncertainty of the CG in feet/second.

(184) Wind Relative Flight Path Angle - The wind relative flight path angle as seen in ECI coordinates in degrees relative to the CG.

(185) Wind Relative Flight Path Angle Uncertainty - The wind relative flight path angle uncertainty as seen in ECI coordinates in degrees relative to the CG.

(186) Wind Relative Azimuth Angle - The wind relative azimuth of the velocity vector as seen in the ECI coordinates in degrees measured from the CG positive CLOCKWISE from North.

(187) Wind Relative Azimuth Angle Uncertainty - The wind relative azimuth uncertainty of the velocity vector as seen in the ECI coordinates in degrees measured from the CG positive CLOCKWISE from North.

(188) Surface Range - The surface range from the nav base to the launch site (on ascent) or the runway (on descent) measured in feet.

(189) Wind Relative Angle of Attack - The wind relative angle of attack in degrees for the CG

(190) Wind Relative Angle of Attack Uncertainty - The wind relative angle of attack uncertainty in degrees for the CG.

(191) Wind Relative Guidance Sideslip Angle - The wind relative guidance sideslip angle in degrees for the CG.

(192) Wind Relative Guidance Sideslip Angle Uncertainty - The wind relative guidance sideslip angle uncertainty in degrees for the CG.

(193) Wind Relative Dynamic Pressure - The wind relative dynamic pressure for the velocity of the CG in pounds per square foot.

(194) Wind Relative Dynamic Pressure Uncertainty - The wind relative dynamic

(194) Wind Relative Dynamic Pressure Uncertainty - The wind relative dynamic pressure uncertainty for the velocity of the CG in pounds per square foot.

(195) Wind Relative Pitch Dynamic Pressure - The wind relative pitch dynamic pressure for the CG in pound-degrees per square foot.

(196) Wind Relative Yaw Dynamic Pressure - The wind relative yaw dynamic pressure for the CG in pound-degrees per square foot.

(197) MACH Number - The wind relative mach number at the CG.

(198) MACH Number Uncertainty - The wind relative mach number uncertainty at the CG.

(199) Viscosity - The wind relative viscous parameter at the CG.

(200) Viscosity Uncertainty - The wind relative viscous parameter uncertainty at the CG.

(201) Temperature - The ambient temperature in degrees Rankin at the trajectory position.

(202) Temperature Uncertainty - The temperature systematic uncertainty in degrees Rankin at the trajectory position.

(203) Pressure - The ambient pressure in pounds per square inch at the trajectory position.

(204) Pressure Uncertainty - The pressure systematic uncertainty in pounds per square inch at the trajectory position.

(205) Density - The ambient density in slugs/ft cubed at the trajectory position.

(206) Equivalent Air Speed - The wind relative equivalent air speed at the CG measured in feet per second.

(207) Equivalent Air Speed Uncertainty - The wind relative equivalent air speed uncertainty at the CG measured in feet per second.

(208) Load Factor - The load factor at the CG in g's.

(209) Drag Over Mass - The wind relative drag divided by the mass for the CG.

(210) Lift Over Drag - The wind relative lift divided by the drag for the CG.

(211) Aerodynamic Sideslip - The wind relative aerodynamic sideslip in degrees for the CG.

(212) Aerodynamic Sideslip Uncertainty - The wind relative aerodynamic sideslip uncertainty in degrees for the CG.

(213) to (215) Topedetic Euler Angles - The Euler angles of yaw, pitch, and roll in degrees relative to the topedetic coordinate system.

(216) to (218) Topedetic Euler Angle Rates - The Euler angle rates of yaw, pitch, and roll in degrees/second relative to the topedetic coordinate system.

(219) to (221) Inertial Body Angular Rates - The inertial body angular rates around the X (219), Y (220), and Z (221) body axes in degrees per second.

(222) to (224) Inertial Body Angular Rate Uncertainty - The inertial body angular rate uncertainties around the X (222), Y (223), and Z (224) body axes in degrees per second.

(225) to (227) Inertial Body Angular Accelerations - The inertial body angular accelerations around the X (225), Y (226), and Z (227) body axes in degrees per second per second.

(228) to (230) Inertial Body Angular Acceleration Uncertainty - The inertial body angular acceleration uncertainties around the X (228), Y (229), and Z (230) body axes in degrees per second per second.

(231) to (233) Contact Acceleration of the CG - The contact acceleration of the CG expressed in the x,y,z body axis coordinates.

(234) to (236) Contact Acceleration Uncertainty of the CG - The contact acceleration uncertainty of the CG expressed in the x,y,z body axis coordinates.

(237) to (239) CG Location - The current CG location in feet in body axis coordinates.